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Notes

Cienc. y Téc.	*Ciencia y Técnica.* Publication resumed with issue of January, 1954, an address changed to Centro Estudiantes de Ingenieria, "La Linea Recta, Diagonal Julio a Roca 546 (ler piso) Buenos Aires.
Applic. and Industr.	*Applications and Industry.* No. 5 (1953)—No. 10 (1954) inclusive of this publ cation are issued in collected form in *Transactions of the American Institute o Electrical Engineers*, Volume 72, Part II (1953), without change of paginatio
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Energetyka [*Katowice*]	The journal formerly listed as *Energetyka* will now appear thus.
Pwr Apparatus Syst.	*Power Apparatus and Systems.* No. 4 (1953)—No. 9 (1953) inclusive of thi publication are issued in collected form in *Transactions of the America Institute of Electrical Engineers*, Volume 72, Part III (1953) without change o pagination.

Errata

Annual Index (1952) p. vii, line 10: *for* Abstract 8262 *read* Abstract 8252.
,, ,, (1953) p. ix, column 2, line 25: *for* Abstr. 6429 (1953) *read* Abstr. 6429 (1952).
Abstr. 684 (1954) line 3: *for* R. VAN LIESHAUT *read* R. VAN LIESHOUT.
Abstr. 3246 (1954) line 4: *for* $\sin(\pi d/\lambda)\pi/\lambda$ *read* $\sin(\pi d/\lambda)/(\pi/\lambda)$
line 8: *for* $\sin(\pi l/\lambda)/\pi\lambda/\lambda$ *read* $\sin(\pi l/\lambda)/(\pi l/\lambda)$.
Abstr. 4158 (1954) line 2: *for* D. IVANENKO *read* D. IWANENKO.
Author Index (April, 1954): *for* TUSKADA, K., 3729, *read* TSUKADA, K., 3729.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 2008–9 (1952):	**22,** 764 (*April*, 1954).
Abstr. 639 (1953):	**10,** 369 (*Sept.*, 1953).
Abstr. 3488 (1953):	**238,** 1076 (*March* 1, 1954).
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Abstr. 5965 (1953):	**22,** 764 (*April*, 1954).
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Abstr. 8660 (1953):	**10,** 652 (*Dec.*, 1953).
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Abstr. 3928 (1954):	**22,** 766 (*April*, 1954).
Abstr. 4342 (1954):	**27,** *No.* 1, 80 (1954).
Abstr. 5033 (1954):	**25,** 543 (*April*, 1954).

MATHEMATICS 51

512.99

5200. On vector sums and products. M. S. KLAMKIN. *Amer. J. Phys.*, **22**, 159–61 (*April*, 1954).

The usual expressions for the vector sum, scalar product and vector product of two vectors are derived from postulated properties having direct physical significance. A.

517.392 : 523.877

5201. Formulae and tables for the numerical computation of mean intensities and fluxes in a stellar atmosphere. A. REIZ. *Ark. Astron.*, **1**, *Paper* 32, 475–82 (1954).

Newton–Cotes type integration formulae $\sum_{i=1}^{r} p_i(\tau) f(t_i)$ for $\int_0^\tau f(t)E_{1,2}(\tau - t)dt$ are discussed. The weight functions $p_i(\tau)$ are tabulated in the case of five equidistant rational arguments t_i for various ranges τ. R. A. NEWING

517.43 : 621.391

5202. Approximation methods in functional calculus. J. BRODIN. *Ann. Télécomm.*, **9**, 1–8 (*Jan.*, 1954) *In French.*

From the point of view of mathematics, an operator represents a mechanical or electrical organ, establishing a functional relation between the oscillograms of the signal and response. This discussion is only concerned with linear functional relations for which the indicial response is a bounded function of the time-to-crest of a step signal. From this hypothesis a major operator can be defined and the convergence of a series of operators can be studied. Applications to Volterra's equation and Pipes' differential equation of the second order with time-dependent coefficients. A. V. BREHME (R)

517.431

5203. The theory of vector spherical harmonics. E. L. HILL. *Amer. J. Phys.*, **22**, 211–14 (*April*, 1954).

Differential equations involving vector fields expressed in terms of spherical polar co-ordinates are readily manipulated by the use of vector spherical harmonics. The explicit definitions of these functions and a sufficient set of formulae for easy calculation are given. A.

517.947.43

5204. Round-off errors in the solution of the heat conduction equation by relaxation methods. A. R. MITCHELL. *Appl. sci. Res. A*, **4**, *No.* 2, 109–19 (1953).

A method is developed for assessing the magnitude of the round-off errors which arise in a relaxational solution of the heat conduction equation. The finite difference approximation used is the stable six-point formula which is relaxational in the distance co-ordinate and step-by-step in the time co-ordinate of residuals. If, in the network covering the field, time and distance are constant along rows and columns respectively, the maximum rounding error always occurs at a node in the first or last row. The parameters having most effect on the magnitude of the maximum error are the number of columns and the mesh ratio, whilst the number of rows seems to be relatively unimportant. Formulae are derived for obtaining round-off errors for several different distributions of residuals. A.

518.4 : 548.735

A graphical method of evaluating trigonometric functions used in crystal structure analysis. *See Abstr.* 6135

518.5

5205. Dead programmes for a magnetic drum automatic computer. W. L. VAN DER POEL. *Appl. sci. Res. B*, **3**, *No.* 3, 190–8 (1953).

In an automatic computer with a memory for both numbers and instructions a mistake in an instruction sometimes causes a complete breakdown of the programme. In a machine with a memory having permanence these breakdowns can be prevented by blocking a part of the memory for writing. Standard sub-programmes which occur frequently can be placed in this dead part of the memory. These programmes require a special treatment of instructions which are changed by the programme itself. A description is given of a method for storing the return instructions in a hierarchy of sub-programmes, and of a technique for using variable instructions in a dead programme. A.

518.5

5206. A note on an improved planimetric method of harmonic analysis. J. CREASE AND M. J. TUCKER. *Brit. J. appl. Phys.*, **5**, 143–5 (*April*, 1954).

Describes an improvement to a method of harmonic analysis by Daniels [Abstr. 6989 (1952)]. Both the original and improved methods use only a planimeter and a set of ruled grids. An approximate value of a sine or cosine coefficient is obtained from a single tracing of the plotted function and the accuracy may be improved by means of correction terms from the higher-order harmonics. In the improved method described here the number and importance of the correction terms is much less than in Daniels' original method. A.

518.5 : 530.145

5207. An integrating apparatus for the Schrödinger equation. K. ANTONOWICZ. *Acta phys. Polon.*, **12**, *No.* 3–4, 163–9 (1953).

An apparatus has been constructed based on an analogy between the equation of motion of a magnetic needle and the one-dimensional Schrödinger equation. The apparatus was checked with a harmonic oscillator as an example. Eigenfunctions were obtained and by comparison with those given by theory were shown to be in agreement within an error of 1%. A.

519.2

5208. On a statistical apparatus. W. FUCKS. Note in *Naturwissenschaften*, **41**, *No.* 3, 57–8 (1954) *In German.*

An investigation of the theory of Galton's apparatus. N. L. JOHNSON

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.6 : 523.77 : 621–526

5209. Rocket-borne servo tracks the sun. D. S. Stacey, G. A. Stith, R. A. Nidey and W. B. Pietenpol. *Electronics*, **27**, 149–51 (*Jan.*, 1954).

A spectrograph mounted in the nose cone of a rocket is continuously directed towards the sun by a biaxial servomechanism. The purpose of the apparatus is to examine the ultraviolet region of the sun's radiation and the Lyman-alpha hydrogen line at 1216 Å has already been observed. Sighting on the sun is carried out by a balanced phototube system with coarse and fine controls. The azimuth motor has to counteract a steady rocket rotation of about 1·5 revolutions per sec and a field control motor maintains the required elevation via a precision gear train with a ratio of 1080 : 1. In order to protect the apparatus the system is stowed away whenever the rocket is within the lower portion of the earth's atmosphere. G. HOWELLS

523.162.2

5210. Red-shifts in the spectra of celestial bodies. E. Finlay-Freundlich. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 192–3 (*Feb.*, 1954).

Observed shifts for *B*- and *O*-stars can be represented by the empirical formula $\Delta\lambda/\lambda = AT^4l$, which is interpreted as arising from loss of energy when light passes through a radiation field, T being the temperature, l the length of the path through the field and A a constant. The formula is considered to be of general applicability; for Hubble shifts it indicates an intergalactic temperature of order 1·5°K. R. A. NEWING

523.162.2

5211. On the interpretation of Freundlich's red-shift formula. M. Born. *Proc. Phys. Soc.* [*London*] *A*, **67**, 193–4 (*Feb.*, 1954).

The formula (preceding abstract) is written as $\Delta\lambda/\lambda = CN\lambda_0/\bar{\lambda}$, where C is a dimensionless constant, $\lambda_0 = 2\pi l_0$ = Compton wavelength, $\bar{\lambda}$ = wavelength corresponding to mean frequency of the radiation field and $N = ll_0^2n$ where n is the photon density. It is concluded that the red-shift could be explained as a sequence of photon-photon collisions with an effective cross-section l_0^2, the collisions not being accompanied by deflections. Secondary particles, if photons, would be of radar frequencies. The theory would involve the appearance of an absolute length in the field equations for the vacuum. R. A. NEWING

523.165

5212. Galactic magnetic fields and the origin of cosmic radiation. E. Fermi. *Astrophys. J.*, **119**, 1–6 (*Jan.*, 1954).

523.165

5213. Identification of the radio sources in Cassiopeia, Cygnus A, and Puppis A. W. Baade and R. Minkowski. *Astrophys. J.*, **119**, 206–14 (*Jan.*, 1954).

The radio sources in Cassiopeia and Puppis A are identified with a new type of galactic emission nebulosity. The outstanding features of these nebulosities are very large internal random velocities. The radio source Cygnus A is an extragalactic object, two galaxies in actual collision. A.

523.1

5214. On the identification of radio sources. W. Baade and R. Minkowski. *Astrophys. J.*, **11** 215–31 (*Jan.*, 1954).

A discussion of the astronomical evidence concer ing objects identified as discrete radio sources sho that the following four types of objects are nc recognized: (I) remnants of supernovae; (II) galact nebulosities of a new type; (III) peculiar extragalact nebulae; (IV) normal extragalactic nebulae. discussion of the distribution of the general galact radiation favours the assumption that this radiatic is emitted by objects in population II and therefo probably by stars.

523.1

5215. The power radiated by some discrete sourc of radio noise. R. Minkowski and J. L. Greenstei *Astrophys. J.*, **119**, 238–42 (*Jan.*, 1954).

The identification by Baade and Minkowski some of the strongest sources of radio noise permi one to estimate the energy emitted per unit volum These strongest discrete sources radiate at a ra higher by many orders of magnitude than the Galax Collisions of gas masses may provide sufficient energ

523.16

5216. Generation of radio noise by cosmic source J. H. Piddington; F. Hoyle. *Nature* [*London*] **17** 482–3, 483–4 (*March* 13, 1954).

Attention is drawn by Piddington to the omissic of a numerical factor in Hoyle's estimate of radi emission from his proposed thermal process in whic electron acceleration is provided by local concentra tions of space charge [Abstr. 8186 (1953)]. Th revised estimates show that the new theory inadequate to account for observed radiation a metre wavelengths.

Hoyle states that the theory also involves charg separation on too fine a scale and non-therma processes are now examined. Synchrotron-typ emission by relativistic electrons is suggested as possible mechanism. Difficulties concerning th presence of such electrons in interstellar space ar mentioned, but it is considered that these could b overcome on account of the high velocities occurrin in strong radio sources. Quantitative aspects of th mechanism are briefly examined and it is conclude that the theory could provide a satisfactory frequenc spectrum. R. A. NEWIN

523.165 : 523.8

5217. The spectrum of the radio source in Cassiopeia R. Minkowski and L. H. Aller. *Astrophys. J* **119**, 232–7 (*Jan.*, 1954).

The Cassiopeia radio source shows [O I] an [O III] lines which are of equal intensity but at leas five times stronger than Hα or λ3727 of [O II]. Thi unusual type of emission spectrum may be under stood if we suppose that the electron density lie between 10^3 and 10^4/cm^3 and the electron temperatur is less than 15 000°K. No high-temperature source o radiation appears to be involved. The emitte radiation appears to be derived from the kineti

energy of the free electrons. Dissipation of mechanical energy in the filaments may serve to maintain an electron temperature in the neighbourhood of 10 000°K. A.

523.2

5218. On Kuiper's theory of the origin of the solar system. D. TER HAAR. *Proc. Roy. Soc. Edinburgh A*, **64**, *No.* 1, 1–8 (1953).

Kuiper's recent theory of the origin of the solar system [Abstr. 5014 (1951)] is criticized on several grounds. Firstly, it is pointed out that the empirical relation between the ratio of the masses of two consecutive planets (satellites) on the one hand and the ratio of their distances from the sun (primary) on the other hand is not the one discussed by Kuiper. Secondly, it is shown that the densities needed for a successful application of Kuiper's theory are probably not attained in the system considered by him. Finally, some other points are discussed which enter into most theories about the origin of the solar system. A.

523.25

5219. On the composition of the bodies of the solar system. H. P. BERLAGE. *Proc. K. Ned. Akad. Wetensch. B*, **56**, *No.* 1, 45–55 (1953).

An attempt is made to arrange current aspects of the internal constitution of the bodies of the solar system into one coherent picture. A.

523.25

5220. The masses of planets and satellites derived from the disc theory of the origin of the solar system. H. P. BERLAGE. *Proc. K. Ned. Akad. Wetensch. B*, **56**, *No.* 1, 56–66 (1953).

It is shown that the disk theory of the origin of the planetary system in the form adopted by the author leads to a formula for the masses of the planets, and for the masses of the bodies of any secondary system, which is easily adaptable to the observed values and besides suggests a definite answer to some related questions. A.

523.34

5221. The distribution of lunar craters. D. W. G. ARTHUR. *J. Brit. Astron. Assoc.*, **64**, 127–32 (*Feb.*, 1954).

523.37

5222. Ultraviolet spectral radiant energy reflected from the moon. R. STAIR AND R. JOHNSTON. *J. Res. Nat. Bur. Stand.*, **51**, 81–4 (*Aug.*, 1953).

Results are given of some measurements on the ultraviolet and short-wavelength visible spectral radiant energy reflected from the surface of the full moon, made from October to December 1952, at Washington, D.C. Although the reflected lunar spectrum contains all the Fraunhofer bands as found in direct sunlight with approximately the same relative intensities in the visible spectrum, intense absorption occurs for some of the ultraviolet wavelengths. Selective absorption for wavelengths in the spectral regions of 380 to 390 mμ and less than 360 mμ indicates the possibility of a lunar reflecting surface similar to that of powdered glassy silicates. A.

523.45 : 523.745

5223. A planetary-atmospheric response to solar activity. R. SHAPIRO. *J. Meteorol.*, **10**, 350–5 (*Oct.*, 1953).

The brightness of the planet Jupiter is found to be related to mean annual and monthly relative sunspot numbers which are used to indicate the general level of solar activity. The evidence for the relationship is presented and is examined for possible meteorological implications. A.

523.51 : 537.591.8

5224. Some remarks on the life-history of meteorites. S. F. SINGER. *Astrophys. J.*, **119**, 291–3 (*Jan.*, 1954).

Consideration of the production of helium 3 by cosmic rays in meteorites makes possible corrections to their "ages" by allowing the cosmic-ray-produced helium to be subtracted. A method is indicated here for placing some limits on the date of creation of a meteorite; it is based on the determination of the empirical rate of production of cosmic-ray helium, which is then compared with the theoretical value. This method is applied to the Bethany (Harvard) meteorite. Further applications are suggested for studying the physical history of the meteorite surface, particularly in its traversal of the earth's atmosphere. A.

523.59

5225. The space distribution of zodiacal-light material. H. ELSÄSSER. *Z. Astrophys.*, **33**, *No.* 4, 274–85 (1954) *In German.*

The distribution of material is deduced from observations of the brightness and polarization of the zodiacal light. The surfaces of constant electron density in interplanetary space can be represented by ellipsoids with axes of rotation through the sun and perpendicular to the ecliptic plane. Distribution curves of particle density with distance from the ecliptic plane are also given. M. W. OVENDEN

523.59 : 523.755

5226. Observations of the zodiacal light. F. E. ROACH, H. B. PETTIT, E. TANDBERG-HANSSEN AND D. N. DAVIS. *Astrophys. J.*, **119**, 253–73 (*Jan.*, 1954).

Observations of the zodiacal light for five nights between November 1952, and April 1953, are recorded. The variation of brightness in the plane of the ecliptic for elongations from the sun from 30° to 100° is given. A comparison with photometric measurements of the outer corona supports the hypothesis that the outer corona and the inner zodiacal light have a common physical origin. A study of the zodiacal light with filters centred on the upper-atmosphere emissions [O I] 5577, 6300 and Na I 5893 indicates (*a*) that the light has the spectral characteristics of the sun, and (*b*) that there is no measurable enhancement of the nightglow in the zodiacal light. A.

523.72 : 523.755

5227. Distribution of radio-frequency brightness across the solar disk and the derivation of a model corona. P. A. O'BRIEN AND C. J. BELL. Letter in *Nature* [*London*] **173**, 219 (*Jan.* 30, 1954).

From observations of the distribution of brightness across the solar disk on 1·4, 3·7 and 7·9 metres, the following expressions for electron density N and temperature T at radial distance (from the solar centre) R in the corona have been derived empirically: $N = 1{\cdot}6\times10^{8}\,R^{-5}$ cm^{-3} and $T = 2\times10^{6}\,R^{-3}$ deg. K. These formulae give the best fit to the observations over the range 1·2 to 3 times the photospheric radius. A slight defect of observed intensity at small radii

over the predictions of the above model on 1·4 and 3·7 metres is attributed to scattering by irregularities of electron density in the corona. M. W. OVENDEN

523.746

5228. Identification of sunspots. H. ALFVÉN. *Tellus*, **5**, 423–45 (*Nov.*, 1953).

According to the magneto-hydrodynamic theory of sunspots there should be a correlation between the spots on one hemisphere during a certain cycle and spots on the opposite hemisphere during the following cycle. This has been statistically confirmed by Galvenius and Wold, and by Whittle. It is pointed out that individual sunspot groups may be reproduced at the opposite hemisphere during the following cycle. An analysis of the sunspots between $-4°$ and $+4°$ seems to support this conclusion, and a number of sunspots are "identified" as being produced by the same original disturbance in the solar core. A.

523.746

5229. The hypothetical inclination of the axes of sunspots. A. BRUZEK. *Z. Astrophys.*, **33**, *No.* 4, 267–73 (1954) *In German.*

Several authors proposed to accept the existence of a systematic West-inclination of the axes of sunspots (in order to explain a statistically found East excess of the spots); the present author finds no justification for this. He investigates, for the period 1889–1943, the sum of the sunspot areas as a function of the distance from the central meridian. It appears that the distribution function is symmetrical, and that the asymmetry for spots of great longevity is only a selection phenomenon; for these and other reasons the author denies the possibility of any inclination effect. A. BEER

523.75

5230. The visual continuous spectrum and the thickness of a prominence. S. G. M. HAUG. *Proc. K. Ned. Akad. Wetensch. B*, **55**, 517–23 (1952).

Plates, taken by Doorn during the solar eclipse of June 29, 1927, show a continuous spectrum of a strong prominence, in the visual region, which is just measurable. The line spectrum of hydrogen is too strong but its intensity can be estimated, under certain assumptions, by comparison with a fainter prominence, assuming that the continuous spectrum is mainly produced by scattering of photospheric light by the free electrons in the prominence, and making use of the results that Unsöld obtained from the data of the same plates, one can derive, for this particular prominence, both the concentration of electrons $1·6\times10^{10}$, and the thickness in the line of sight 25 000 km. This is higher than the estimate of Pettit, who gives about 10 000 km. A.

523.75

5231. On the thickness of prominences in the line of sight. D. KOELBLOED. *Proc. K. Ned. Akad. Wetensch. B*, **55**, 524–6 (1952).

From the absolute intensity of the continuous spectrum, the thickness of two prominences in the line of sight were determined. The spectra were those taken by Davidson during the solar eclipse of January 14, 1926. For the high prominence (height 14 000 km) a mean value of 10 000 km and for the low prominence (height 700 km) 20 000 km was found for the thickness in the line of sight.

523.7

5232. The continuous spectrum of a prominence observed at the total solar eclipse of 1952 February 25. R. O. REDMAN AND H. ZANSTRA. *Proc. K. Ned. Akad. Wetensch. B*, **55**, 598–609 (1952).

An ultraviolet slit spectrum of the rather faint but conspicuous prominence near the point of third contact, at P.A. about 270°, was obtained at the eclipse at Khartoum. The ratio of the Ba_c spectrum to the continuous spectrum between the Balmer lines yields a proton or electron concentration of $0·7\times10^{10}$ per cm³ if an electron temperature of 5000° assumed and 5×10^{10} per cm³ for 15 000°. The thickness of the prominence in the line of sight resulting from the absolute intensity of the continuous spectrum is then 40 000 km for 5000° and 6000 km for 15 000°, the latter value being about the same as the thickness derived from absorption data (spectroheliograms). The values obtained are of the same order as estimates obtained from older eclipse material (see preceding abstracts). A.

523.7

5233. Solar flares and the yellow coronal line. F. P. DOLDER, W. O. ROBERTS AND D. E. BILLINGS. *Astrophys. J.*, **119**, 120–3 (*Jan.*, 1954).

Emission of the unidentified yellow coronal line visible at Climax from 1946 to 1950 is shown to be highly correlated with flares at the sun's limb at the same position, indicating a close relationship between the two phenomena. The probability of a chance correlation as close as the observed is less than 2×10^{-5}. A.

523.7

5234. The abundance of beryllium in the sun. J. L. GREENSTEIN AND E. TANDBERG-HANSSEN. *Astrophys. J.*, **119**, 113–19 (*Jan.*, 1954).

The presence of lines of both neutral and ionized beryllium in the solar spectrum has been confirmed and their intensities measured. Based on dependable *f*-values, the abundance ratios are found to be $Be/H = 10^{-10}$, $Be/Li = 8$, $Be/Ca = 6\times10^{-5}$. A striking excess of beryllium as compared with lithium is found in the sun. The Be abundance is about the same as on the earth or in meteorites. Thermonuclear disintegration of Be occurs rapidly at temperatures above $3·6\times10^{6°}$K. No processes are found that produce it. It is destroyed somewhat less rapidly than is Li. Convection or circulation mixing the atmosphere and the outer envelope would destroy Li and leave Be unaffected if it penetrated to layers at a temperature of 3·0 million degrees, but not above 3·6 million degrees. A.

523.823.4

5235. Stellar model with large radius. T. C. ROY. *Proc. Nat. Inst. Sci. India*, **19**, 317–21 (*May–June*, 1953).

A model star of non-homogeneous composition is constructed having a convective core and a radiative envelope. It is shown that to get a radius nearly as large as was found by Li Hen and Schwarzchild (1949), it is not necessary to have a wide variation in composition as generally happens in the cases considered

by them. It is shown that even if quite small variation in the percentage of hydrogen and helium content occurs between the inner and outer regions of the star a stellar radius nearly of the same order of magnitude as in the models of Li Hen and Schwarzchild may be expected. In other respects the author's results generally confirm those of Li Hen and Schwarzchild. A.

523.85

5236. On a steady gravitational field of a star cluster free from singularities. N. R. SEN AND T. C. ROY. *Z. Astrophys.*, **34**, *No.* 2, 84–90 (1954).

A stationary gravitational field of a spherical star cluster is constructed, in the manner proposed by Einstein, by a suitable statistical distribution of stars in circular orbits. Both the internal and external fields are entirely free from singularities and the external Schwarzschild field may be fitted on to the field of the expanding universe. The gravitational mass of the cluster which equals its rest mass at infinite diffusion decreases as the cluster contracts, and passes through a minimum, the decrease being at most 5%. For given rest mass the cluster has a minimum radius. The velocities of the peripheral stars corresponding to configurations near those minima are comparable to the velocity of light. For astronomical velocities the gravitational and the rest masses are practically identical and the classical Newtonian dynamics is valid. A.

523.852 : 537.591.1

5237. On a magnetic property of some gaseous nebulae. G. A. SHAĬN AND V. F. GAZE. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17**, *No.* 1, 114–18 (1953) *In Russian.*

According to the authors, the assumption that magnetic fields of the order of 10^{-5} gauss exist in the interstellar space of the Galaxy meets with some objections. They show that some indications exist about magnetohydrodynamic processes in some nebulae which could be assumed as examples of the magnetic fields postulated in Fermi's theory [transcription of Wataghin's summary, Abstr. 5747 (1954)].

523.877

5238. The propagation of weak spherical shocks in stars. G. B. WHITHAM. *Commun. pure appl. Math.*, **6**, 397–414 (*Aug.*, 1953).

Mathematical considerations of the shocks resulting from an explosion at the centre of a polytropic star. The linearized theory is discussed in detail and it is shown how the solution can be adapted to the correct (non-linear) theory, enabling calculation of the head shock. The theory has an important bearing on the study of novae. G. M. BROWN

523.877

5239. Radial oscillations of a composite model. C. PRASAD. *Proc. Nat. Inst. Sci. India*, **19**, 739–46 (*Nov.–Dec.*, 1953).

A composite model consisting of a homogeneous compressible core surrounded by an envelope of small uniform density is considered, and the period and amplitude of oscillation in the first three radial oscillation modes obtained for five cases with different ratios of the densities and radii. Considering the most general motion, it is shown that it is not at all necessary to place restrictions on these ratios as found previously by other investigators. It is also shown that by a suitable choice of these ratios it is possible to obtain a model for which the period of the fundamental mode is less than twice the period of the first overtone. A.

523.877

5240. Temperature and electron pressure in the atmospheres of S Sagittae and T Vulpeculae. R. LÜST-KULKA. *Z. Astrophys.*, **33**, *No.* 4, 211–44 (1954) *In German.*

Spectrophotometric measurements of these Cepheid variables led to equivalent widths for 51 metallic lines for the various phases of the light variation, and to corresponding curves of growth. These have been compared with the theoretical curves, thus giving damping, atmospheric turbulence velocities, excitation temperatures of Fe I, and also values of log NH for the different elements. Saha's equation, and appropriate assumptions concerning the relative abundances of the elements in these stars and in the sun, and the rôle of the negative H-ion, led to electron pressures relative to the sun. The variations of temperature, electron pressure, and abundances at the phases between maximum and minimum of light showed behaviour similar to that in δ Cephei, but with smaller amplitudes (for which an explanation is offered). No variation of damping and turbulence with phase had been measurable. The mean numerical values obtained are similar to those found for some typical supergiants. A. BEER

523.877

5241. The gravitational instability of an infinite homogeneous medium when Coriolis force is acting and a magnetic field is present. S. CHANDRASEKHAR. *Astrophys. J.*, **119**, 7–9 (*Jan.*, 1954).

It is shown that Jeans's criterion for the gravitational instability of an infinite homogeneous medium is unaffected by the presence of a magnetic field, even if the system is partaking in rotation and Coriolis force is operative. A.

523.877

5242. On the pulsation of a star in which there is a prevalent magnetic field. S. CHANDRASEKHAR AND D. N. LIMBER. *Astrophys. J.*, **119**, 10–13 (*Jan.*, 1954).

A simple approximate formula is obtained for the frequency (σ) of radial pulsation of a gaseous star in which there is a prevalent magnetic field. The formula is $\sigma^2 I = -(3\gamma - 4)(\Omega - \mathfrak{M})$, where γ is the ratio of the specific heats, $I = \int_0^M r^2 dm(r)$, and Ω and $\mathfrak{M}$ denote the gravitational potential energy and the magnetic energy of the star, respectively. The formula is derived from the virial theorem in the form recently established by Chandrasekhar and Fermi; and it supports their conclusion that the period of pulsation can be made as long as one may desire by letting the magnetic energy approach the upper limit (namely, $|\Omega|$) set by the virial theorem. A.

523.877

5243. On equilibrium configurations of oblate fluid spheroids in a magnetic field. G. GJELLESTAD. *Astrophys. J.*, **119**, 14–33 (*Jan.*, 1954).

It is shown that a homogeneous incompressible

oblate fluid spheroid of infinite electrical conductivity can be an equilibrium configuration if it has a uniform internal magnetic field and an external dipole field. The condition for stability is established, and the equilibrium spheroids are discussed briefly. It is shown that an oblate spheroidal cloud in an interstellar magnetic field in a spiral arm, as estimated by Chandrasekhar and Fermi, will be stable if the density is at least 14 times larger than the average density of the surrounding interstellar matter, while it will be unstable and contract to a disk-like shape or disintegrate if the density is less than 14 times the average density. A.

523.877

5244. The transfer of radiation by an emitting atmosphere. II. H. G. HORAK AND C. A. LUNDQUIST. *Astrophys. J.*, **119,** 42–50 (*Jan.*, 1954).

For Pt I, see Abstr. 3840 (1953). The transfer of radiation by a plane-parallel atmosphere containing a linear distribution of emission sources is considered for the isotropic case. The exact expressions for the emergent intensity are derived for both finite and semi-infinite atmospheres. It is shown how the exact field at any depth can be obtained. A.

523.877

5245. Exact curves of growth. III. The Schuster–Schwarzschild model. M. H. WRUBEL. *Astrophys. J.*, **119,** 51–7 (*Jan.*, 1954).

Curves of growth have been computed for six values of the damping from $\log a = -3{\cdot}0$ to $\log a = -1{\cdot}0$ and four values of $I^{(0)}/I^{(1)}$ from $\frac{1}{4}$ to 2, using Chandrasekhar's exact solution of the equation of transfer for the Schuster–Schwarzschild model and Harris' expansion of the line-scattering coefficient. A.

523.877

5246. Compton scattering by electron atmospheres. I. The Schuster problem. F. N. EDMONDS, JR. *Astrophys. J.*, **119,** 58–69 (*Jan.*, 1954).

The problem of the transfer of radiation in an atmosphere of free electrons is solved in the first approximation under the conditions of the standard Schuster problem of line formation. In the solution, account is taken of the noncoherent character of the electron scattering due to the Doppler shifts arising from a Maxwellian distribution of thermal velocities, the red shift of the Compton effect, and a non-Doppler blue shift arising from thermal motions and first pointed out by Dirac. The latter two effects, designated as "Compton scattering," are shown to produce asymmetries in spectral lines which would be very difficult to detect for stellar temperatures, as they are much smaller than the thermal broadening. A.

523.877 : 517.392

Formulae and tables for the numerical computation of mean intensities and fluxes in a stellar atmosphe *See Abstr.* 5201

523.877 : 535.34

5247. Contribution to the study of stellar atm spheres. II. The coefficient of absorption. A. MASA *Mem. Soc. Astron. Ital.*, **25,** *No.* 2, 117–25 (1954) *Italian.*

For Pt I, see Abstr. 7407 (1953). The coefficien per gram of stellar material are calculated for pu hydrogen, and for hydrogen and helium in equal pa by weight, as functions of the wavelength for t following temperatures: $\log T = 4{\cdot}00005$; $4{\cdot}4999$ $4{\cdot}70001$. The Rosseland and Planck means a calculated for electronic pressures $\log Pe = 1{\cdot}$ $3{\cdot}8$.

523.877 : 539.172.

The $He^3 + He^3$ reactions. *See Abstr.* 5962

525.62 : 551.515

5248. Tidal forces and the formation of hurricane C. H. SMILEY. Letter in *Nature* [*London*] **173,** 3 (*Feb.* 27, 1954).

The tidal force due to the sun and a moon near ne (or full) acting on an atmospheric element on a August day tends to produce an anticlockwise motio viewed from above when located at a point south o the sub-solar latitude and north of the equator. A the sun moves southward in August and earl September the latitudes where the highest atmo spheric tides would be expected (considered sem diurnal) would fall alternatively north and south o the equator with successive points approachin There might be one time when the separation of th two lattitudes corresponds to a natural frequency o oscillation of the atmosphere. There could corre spondingly be an increase in hurricane frequency i the North Atlantic before Sept. 23 and a decreas shortly after. The idea was tested for tropical storm over the period 1900–49 and frequencies note For 10-year and for 4- and 5-year blocks th significance is small. It is suggested, however, tha this might form a trigger action. R. S. REA

525.72

5249. Comparisons of stellar scintillation with imag motion. R. HOSFELD. *J. Opt. Soc. Amer.*, **44,** 284– (*April*, 1954).

Stellar scintillation and stellar-image motion ar shown by three types of observations to be essentiall independent criteria of astronomical "seeing." I particular, it is demonstrated that scintillation is no produced in the immediate neighbourhood of the telescope whereas image motion is strongly affecte by local air disturbances. It appears therefore tha stellar scintillation may be a useful probe fo atmospheric studies. A

PHYSICS 53

53.081

5250. Bell and neper. A. D. FOKKER. Letter in *Physica*, **19,** 1208–9 (*Dec.*, 1953).

Explains the definitions of bel and neper as unit steps, $1 : 10$ and $1 : e$ respectively, in the rate of increase of a quantity proceeding in a geometrical series, and advocates that physicists should use the neper as a unit of rate for dimensionless quantities, for example to express thermal expansion in neper/degree. S. WEINTROUB

53.081.5

5251. On the dimensions of angles. O. REEB. *Optik*, **11**, *No.* 2, 75–94 (1954) *In German.*

The author suggests that in addition to the basic units of mass, length and time, angle should be considered as fundamental. Tables are given showing the dimensions of properties used in photometry and rotational dynamics, in terms of the system based on four fundamental units. N. CORCORAN

53.082

5252. Information theory and instrumentation. E. C. CHERRY. *Research*, **6**, 265–70 (*July*, 1953).

The theory of information is a relatively new development which has come about through the need of communication engineers to study the processes of conveying intelligence. The general principles of the theory are also important in instrumentation in which the instruments form a one-way communication channel from nature. A.

FUNDAMENTALS 530.1

530.1 : 530.145

5253. Classification of physical theories according to fundamental constants. S. YIFTAH. *C.R. Acad. Sci.* [*Paris*] **238**, 326–7 (*Jan.* 18, 1954) *In French.*

A short review of existing theories and the roles played by the fundamental constants h, c, γ, m_N (nucleon mass), m_e (electron mass), and e. G. FIELD

530.1 : 530.145

5254. On the problem of fields and their sources. S. YIFTAH. *C.R. Acad. Sci.* [*Paris*] **238**, 452–4 (*Jan.* 25, 1954) *In French.*

Following a previous note (preceding abstract) the dual nature of fields and particles is examined. Two examples (equations of quantized fields and of general relativity) are discussed to illustrate the difficulties encountered in interpreting particles as singularities in the respective fields. G. FIELD

530.12

5255. The external field of a non-static centrally symmetric isolated system in the unified field theory. B. R. RAO. *Proc. Nat. Inst. Sci. India*, **19**, 721–8 (*Sept.–Oct.*, 1953).

This work has arisen out of Bonner's work [Abstr. 2406 (1952)] on static spherically symmetrical fields in the unified field theory as revised by Einstein in 1950. It is found that here also there is a result corresponding to Birkhoff's theorem in general relativity. There exists no non-static spherically symmetrical solution of the unified field equations in space which is free from matter and charge. The interesting feature of the investigation is that it shows clearly how certain features of the total field can exist in isolation but not together. A.

530.12

5256. A generalization of special Lorentz transformation in de Sitter space-time. H. TAKENO. *Progr. theor. Phys.*, **10**, 431–41 (*Oct.*, 1953).

The transformations of the full Lorentz group are generalized in de Sitter space-time from the standpoint of the group of motions. When the curvature of the space-time tends to zero, the generalized transformations tend to the well-known forms of the corresponding transformations of the Lorentz group. Some properties of the transformations, especially those of the generalized special Lorentz transformation are studied. In connection with this research the important rôle the group of motions plays in relativity is considered and the difference of the notion of the invariancy in general relativity and special relativity is also studied. A.

530.12

5257. On a five dimensional representation of the electromagnetic and electron field equations in a curved space-time. M. IKEDA. *Progr. theor. Phys.*, **10**, 483–98 (*Nov.*, 1953).

The equations are proposed for a curved space-time which is immersible in a flat space of five dimensions. This representation is simplified by restricting basic co-ordinate transformations to the transformations that connect the "equivalent" frames of reference. In de Sitter space-time the results are compared with the formalism proposed by Dirac some twenty years ago. A new representation of the electron wave equation is obtained. The present investigation is a generalization of Dirac's formalism to a more general space-time. A.

530.12

5258. Static spherically symmetric space-times in general relativity. H. TAKENO. *Progr. theor. Phys.*, **10**, 509–17 (*Nov.*, 1953).

The term "static" used in general relativity in connection with spherically symmetric space-times is usually used in order to qualify the forms of their line elements. In this paper the concept of the "staticness" of a spherically symmetric space-time is introduced as an intrinsic property of the space-time from the standpoint that the mathematical aspect of general relativity is a theory of analytical invariants. Then some properties of static spherically symmetric space-times are made clear. The method used is based on the theory of characteristic systems of spherically symmetric space-times developed by the writer. Some examples are given. A.

530.12

5259. The inertial field of a charge particle. B. R. RAO AND D. P. GUPTA. *Proc. Nat. Inst. Sci. India*, **19**, 729–38 (*Nov.–Dec.*, 1953).

The electromagnetic field of a charge particle is considered with the general spherically symmetric tensor in polar form with reference to Einstein's equations of a unified field theory. The alternatives of identifying g_{14} or g_{23} as the source of electric field intensity are explored. One of the conclusions arrived at is that g_{14} and g_{23} is the source of electric intensity. The solution of the unified field equations gives a metric for a charge particle the mechanical energy for which is obtained by using the equations of classical general relativity. The energy distribution so determined is found to be weaker than that given by Nordströmo's solution of the gravitational field of a charge particle in general relativity. A.

530.12

5260. On relativistically rigid surfaces of revolution. J. R. POUNDER. *Commun. Dublin Inst. Advanced Stud. A, No.* 11, 55 *pp.* (1954).

A definition of superficial rigidity recently proposed by Synge is applied to what appears to some Galileian observer as a surface of revolution with its axis of symmetry fixed. It is found that the metrical distortions of the meridians and the parallels of latitude of such a moving rigid surface relative to the corresponding surface at rest in a Galileian reference system are governed by relations analogous to the FitzGerald–Lorentz contraction rule. The special cases of (1) uniform rotation about the axis and (2) uniform screw motion along the axis are treated in detail. In (1) there is a radial contraction without change of meridian arc-length; in (2) there is in addition a uniform axial contraction and twist about the axis. If the axial component of velocity in (2) is made to approach the speed of light, the angular velocity remaining finite, then the moving surface shrinks both radially and axially, ultimately having the shape of an infinitesimal circular cylinder with flat ends; at the same time the length of the twisted curves corresponding to the original meridians remains finite. These conclusions are verified by taking the initial surface at rest to be a sphere and a cylinder; the meridian sections of the corresponding surfaces in motion are computed and shown in graphs. When applied to certain surfaces in uniform rotation, in particular multiply-connected ones, the conditions of superficial rigidity are mutually contradictory, unless one allows the formation of edges. A.

530.12

5261. The problem of two bodies in Whitehead's theory. G. L. CLARK. *Proc. Roy. Soc. Edinburgh A,* **64,** *No.* 3, 49–56 (1954).

J. L. Synge [Abstr. 2409 (1952)] has shown that the theories of Einstein and Whitehead predict practically the same phenomena in the solar field. He finds that the rotation of perihelion, the deflection of light rays and the red-shift in the sun's spectrum are the same in both theories. In this paper the motion of the centre of mass of a double star is investigated. It is found that Whitehead's theory predicts a secular acceleration in the direction of the major axis of the orbit towards periastron of the larger mass. The possibility of a binary star having such an acceleration has already been considered by Levi–Civita (1937), and he has given an example in which it may become detectable in less than a century. On the other hand, it has been shown by Eddington and Clark (1938) that there is no secular acceleration according to Einstein's theory. A.

530.12

5262. Relativity theory, Doppler and other spectral displacement effects. M. v. LAUE. *Naturwissenschaften,* **41,** *No.* 2, 25–9 (1954) *In German.*

A detailed examination of the relation between emitted and observed light frequencies in the case of the static metric $ds^2 = d\sigma^2 - c^2dt^2$. Hubble shifts are also discussed. R. A. NEWING

530.12

5263. On the relation between fundamental tensor and affinity in unified field theory. B. BERTC *Nuovo Cimento,* **11,** 358–65 (*April,* 1954).

With the aim of generalizing the relation betw the fundamental tensor and the affine connectio the real and the Hermitian case of the unified f theory, a relation with eight arbitrary constant contemplated; conditions for its general invaria and transposition invariance are imposed, an relation with only two arbitrary coefficients is obtai which, however, except in three particular case substantially nothing else but the real or Hermi relation. One of the particular cases is notewor as it imposes the first quadruplet of Maxwe equations on the skew part of the fundamental ten

530.12 : 530.

5264. Mechanics of a particle. A. PROCA. *J. P Radium,* **15,** 65–72 (*Feb.*, 1954) *In French.*

A generalized classical theory is constructed on assumption that the fundamental equations are to expressed in terms of spinors ξ and ξ^+, spinor sp being related to the space-time of special relativity equation $dx^\varrho/d\tau = \xi^+\gamma^\varrho\xi$, γ^ϱ being Dirac matric The Lagrange function for a free particle is defi and simple first integrals of the equations of mot are found. Free particles possess spin in general a do not move with uniform velocities, but relativis dynamics appears as a special case. The introducti of interaction terms into the Lagrange function discussed, and the equations of motion are deriv for a charged particle in an electromagnetic field.

R. A. NEWI

530.12 : 535

5265. On the wave theory of light in gene relativity. I. Path of light. Y. UENO. *Progr. the Phys.,* **10,** 442–50 (*Oct.*, 1953).

In the general theory of relativity the problems optics have been restricted mostly to those concerni the path of light as null geodesic, and the wa character of light has scarcely been treated. T relation between the method of wave optics and th of geometrical optics concerning the propagation light in a curved space-time is investigated.

530.12 : 53

5266. Permanent motions of a perfect thermodynam fluid. PHAM MAU QUAN. *C.R. Acad. Sci.* [*Paris*] 23 324–5 (*Jan.* 18, 1954) *In French.*

The author's theory in which space-time formalis is extended to include thermodynamic terms is appli to the case of stationary Riemannian space-time.

R. A. NEWI

530.12 : 537

5267. Electric charge and current engendered combined Maxwell–Einstein fields. E. SCHRÖDINGE *Proc. Roy. Irish Acad. A,* **56,** *No.* 2, 13–21 (*Fe* 1954).

The method used by Einstein and Kaufman show that $\Gamma_k \neq 0$ in the generalized field equatio is here used to show that the electric current 4-vect is in general non-zero in a combined gravitational an electromagnetic field. Field variables are develope by successive approximations and it is shown that th condition for zero current is incompatible with th field equations when 2nd-order terms are considere

R. A. NEWIN

530.145

58. A proof of Temple's laws of transition. P. T. NDSBERG. *Ann. Phys.* [*Leipzig*] **14,** *No.* 1–2, 14–16 954).

Extending previous work [Abstr. 2334 (1948)] this per specifies conventions and axioms sufficient to ve a simple approach to quantum theory on the es envisaged by Temple [*Proc. Roy. Soc.*, **138,** 9–94 (Dec. 1, 1932)]. The advantages of the odified scheme here proposed are discussed.

P. M. DAVIDSON

530.145

69. Propagation and wavefunctions in quantum-eory of fields. E. FREESE. Letter in *Nuovo imento*, **11,** 312–15 (*March*, 1954).

Various Green's functions related to those defined Dyson, Feynman and Schwinger are discussed.

G. E. BROWN

530.145

270. Measurement of length and angle in quantum echanics. E. SCHRÖDINGER. Letter in *Nature London*] **173,** 442 (*March* 6, 1954).

The association of operators with common macro-opic observations such as, e.g. the shape of a boratory specimen, is found to be very intricate.

G. E. BROWN

530.145

271. On a regular field theory. I. Classical. . RAYSKI. *Acta phys. Polon.*, **11,** *No.* 3–4, 314–27 951–52).

Regular field equations are derived from a varia-onal principle in a finite space-time domain. The xistence and uniqueness of the solutions in the form f a power series expansion is proved. Conservation aws are inferred. A.

530.145

272. On a non-local field theory. G. WATAGHIN. etter in *Nuovo Cimento*, **10,** 1602–4 (*Nov.*, 1953).

A new form of non-local field theory is suggested, hich starts from the *S*-matrix formalism. It is lustrated by the choice of a simple relativistic cut-off perator [Abstr. 1029 (1954)] which has to be intro-uced into terms corresponding to external lines in a eynman graph. Its square, introduced into internal ines, is interpreted as a statistical weight factor.

G. FIELD

530.145

273. Energy-momentum and charge density in the Kristensen–Møller theory. H. GAUS. *Z. Naturforsch.*, a, 81–90 (*Feb.*, 1954) *In German.*

Using Ôno's method [Abstr. 27 (1953)], expressions or the energy-momentum density and the charge ensity in this non-local theory are given. The orresponding integral quantities and the total angular momentum are obtained, the integral for the total momentum being the same as that found by Pauli [Abstr. 53 (1954)]. W. A. HEPNER

530.145

5274. Quantization of a certain class of non-local field theories. J. RZEWUSKI. *Acta phys. Polon.*, **12,** *No.* 2, 100–22 (1953).

The problem of canonical quantization of non-local field theories is reduced, for a certain class of form-functions, to the problem of canonical quantization of field theories containing higher (eventually infinite) order derivatives of the fields. For finite order derivatives the interaction representation is introduced and general commutation rules between field quantities at two arbitrary points of space-time are constructed. The *S*-matrix is calculated by means of generalized Green's functions. Finally the connection with direct (integral) methods of calculating the *S*-matrix for non-local theories is discussed. A.

530.145

5275. Vacuum polarization in a non-local electrodynamics. W. HANUS AND J. RAYSKI. *Acta phys. Polon.*, **12,** *No.* 3–4, 181–93 (1953).

The vacuum polarization current produced by an external electromagnetic field is computed in the framework of a non-local electrodynamics formulated in Abstr. 1444 (1952); 2001 (1954). The vacuum polarization current is free of the usual divergencies, but does not agree with experiment owing to a pole in the power series expansion in momentum space. This pole may be removed and the agreement with experiment re-established by means of a realistic compensation (simultaneous coupling of the electromagnetic field with charged fermions and bosons). A.

530.145

5276. On the Heisenberg treatment of the field variables. I. WATANABE. *Progr. theor. Phys.*, **10,** 371–85 (*Oct.*, 1953).

Simultaneous integral equations of the vacuum expectation values in the Heisenberg representation are proposed from which to obtain expectation values, *S*-matrix and bound state solutions. The relation of these equations with the methods of Dyson, Bethe–Salpeter and Tomonaga is obvious. Practical calculations are carried out for the system containing one fermion and neutral scalar mesons. Application to other general systems may be possible. A.

530.145

5277. Hamiltonian formalism in non-local field theories. C. HAYASHI. *Progr. theor. Phys.*, **10,** 533–48 (*Nov.*, 1953).

The Yang–Feldman method is generalized in order to obtain a covariant Hamiltonian formulation of quantized fields with non-local interactions. The interaction Hamiltonian is constructed according to the perturbation theory in such a way that the equation of motion in the interaction representation is integrable. The calculations are carried out actually up to the fourth-order approximation. A.

530.145

5278. Generalization of the classical field formalism by means of functionals. M. SCHÖNBERG. Letter in *Nuovo Cimento*, **10,** 1597–1601 (*Nov.*, 1953).

The use of linear and non-linear functionals in obtaining a statistical generalization of the quantum formalism [Abstr. 8220 (1953); 94 (1954)] is shown to permit an extension to field theories for which a variational principle is admissible. As an example of linear field equations, the case of the Klein–Gordon equation is discussed. G. FIELD

530.145

5279. Further remarks on Tamm–Dancoff method. G. MORPURGO. Letter in *Nuovo Cimento*, **11,** 103–5 (*Jan.*, 1954).

See Abstr. 3079 (1954). The calcula ion of the

scattering amplitude for a meson by the Tamm–Dancoff method is extended to second order, to demonstrate renormalization and other difficulties involved. It is shown that the method is not renormalizable without making use of a series expansion in powers of the coupling constant. G. FIELD

530.145

5280. Relations in the second quantization. Wave mechanics in the space of configurations, and second-order problems in the probability calculus. G. BODIOU. *J. Phys. Radium*, **15,** 39–44 (*Jan.*, 1954) *In French.*

A configurational method, operating in a Hilbert space, is described for treating systems of elementary particles. Application is made in the theory of bosons. Certain special determinations of random distributions of N objects are described, and these are generalized to describe a distribution state of a variable number of particles. Operators of annihilation and emission for bosons are considered.

L. S. GODDARD

530.145

5281. The theory of quantized fields. V. J. SCHWINGER. *Phys. Rev.*, **93,** 615–28 (*Feb.* 1, 1954).

For Pt IV, see Abstr. 1022 (1954). The Dirac field, as perturbed by a time-dependent external electromagnetic field that reduces to zero on the boundary surfaces, is the object of discussion. Apart from the modification of the Green's function, the transformation function differs in form from that of the field-free case only by the occurrence of a field-dependent numerical factor, which is expressed as an infinite determinant. It is shown that, for the class of fields characterized by finite space-time integrated energy densities, a modification of this determinant is an integral function of the parameter measuring the strength of the field and can therefore be expressed as a power series with an infinite radius of convergence. The Green's function is derived therefrom as the ratio of two such power series. The transformation function is used as a generating function for the elements of the occupation number labelled scattering matrix S and, in particular, formulae are derived for the probabilities of creating n pairs, for a system initially in the vacuum state. The general matrix element of S is presented, in terms of the classification that employs a time-reversed description for the negative frequency modes, with the aid of a related matrix Σ, which can be viewed as describing the development of the system in proper time. The latter is characterized as indefinite unitary, in contrast with the unitary property of S, which is verified directly. Two appendices are devoted to determinantal properties. A.

530.145

5282. Quantized space-time. E. J. HELLUND AND K. TANAKA. *Phys. Rev.*, **94,** 192–5 (*April* 1, 1954).

The operators and commutators of the space-time co-ordinates and momenta in quantized space-time are formulated. Then the eigenfunctions and eigenvalues of the space-time operators are found. Finally, the time spectrum of the plane-wave solution of the Dirac equation is determined and a convergent perturbation analysis is proposed. A.

530.145 : 5

5283. Note on electrodynamics without potent M. SUFFCZYŃSKI. *Acta phys. Polon.*, **12,** *No.* 2, 8 (1953).

The Hamiltonian of Dirac's new electrodynam formulated without potentials is investigated.

530.145 : 5

5284. Electrodynamics without potentials. L. INFE AND J. PLEBAŃSKI. *Acta phys. Polon.*, **12,** *No.* 123–34 (1953).

A general framework is given for a unitary the of the electromagnetic field characterized by skew-symmetric tensor $p_{\alpha\beta}$. The potentials app only later as derived quantities. The Langrangian this theory is assumed to be an arbitrary function $P = -\frac{1}{4}p_{\alpha\beta}p^{\alpha\beta}$ and $|\rho_0| = c^{-1}(j_\alpha j^\alpha)^{\frac{1}{2}}$, where j^α definition $= c/4\pi p^{\alpha\beta}{}_{,\beta}$. Thus the Lagrangian is function of the field and its derivatives. The fi equations are obtained by variation with respect the field. Generally this "potential-less" electr dynamics is equivalent to Mie's electrodynamics which the potentials are fundamental. But this not always so. Dirac's new electrodynamics can formulated as a "potential-less" unitary thec (Lagrangian $= P + 4\pi k/c|\rho_0|$) but remains outsi the frame of Mie's electrodynamics.

530.1

5285. Remarks on the Lamb shift. V. THORSE Note in *Z. Naturforsch.*, **9a,** 68 (*Jan.*, 1954) *In Germa*

It is stated that on the basis of a simple, modifi consideration of the stationary states [Waldman Abstr. 8240 (1953)] close agreement with the exper mental value can be obtained. W. A. HEPNE

530.14

5286. Theoretical consequences of the electro neutrino theory of photons. B. JOUVET. *C.R. Aca Sci.* [*Paris*] **238,** 327–9 (*Jan.* 18, 1954) *In French.*

See Abstr. 4169, 4175 (1954). A generalized gaug transformation is discussed, leading to the existen of current distributions which do not show a effective electric interaction. The identity of th constant e for all particles is demonstrated. G. FIEL

530.14

5287. The new electromagnetic gauge invariance an superconductivity. B. JOUVET. *C.R. Acad. Sc* [*Paris*] **238,** 454–6 (*Jan.* 25, 1954) *In French.*

The gauge invariance of the theory reported in th preceding abstract is shown to lead to the Londo equations of superconductivity. G. FIEL

530.14

5288. On the properties of propagation functions an renormalization constants of quantized fields. H LEHMANN. *Nuovo Cimento*, **11,** 342–57 (*April*, 1954 *In German.*

An attempt is made to derive some genera properties of the propagation functions for couple fields (Δ_F', S_F') without the use of power series expan sions and to show their connection with the re normalization constants for field operators an masses. Assuming that the coupled functions exist it appears possible to discuss their behaviour near th light-cone (or for large momenta) and to obtain some information about the singularities of these functions when continued analytically. Attempts a

he treatment of unrenormalizable theories are riticized on the basis of these results. Formulae are given for these renormalization constants which contain inequalities for the constants Z_2 and Z_3. Finally it is pointed out that the methods introduced are advantageous also for computations by means of power series expansion. As an example the lowest order correction to the S_F-function in pseudoscalar meson theory is calculated without the appearance of infinite terms during the calculation. A.

530.145

5289. Renormalization. P. T. MATTHEWS AND A. SALAM. *Phys. Rev.*, **94,** 185–91 (*April* 1, 1954).

A theoretical justification for the infinite subtractions, which have to be made in the renormalization of the S matrix, is given along the lines suggested by Gupta and developed by Takeda. It is shown that this is equivalent to working with the renormalized field variables of Dyson, and that the method deals very simply with overlapping divergences and the "wave function" renormalization associated with external lines. It also gives directly Ward's identities and brings out their essential dependence on gauge invariance. The method is applied to free and bound electrons in electrodynamics and all renormalizable meson theories. In the later sections the new method is related to the original method of Dyson; the Bethe–Salpeter equation is renormalized and closed forms are derived for the renormalization constants. A.

530.145 : 539.18

5290. On the neutrino charge of elementary particles. YA. B. ZEL'DOVICH. *Dokl. Akad. Nauk SSSR*, **91,** *No.* 6, 1317–20 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-124.*

To account for the absence of such processes as double β-decay or μ-decay into an electron and a photon the existence and conservation of a "neutrino charge" are postulated. The electron and μ^--meson are assigned equal but opposite unit neutrino charge; nucleons and $\pi^{\pm}$-mesons are assumed to have none, and those of antiparticles are assumed to be of opposite sign. Some consequences are pointed out, and it is finally remarked that if protons, electrons and neutrinos are the only kinds of stable particles, then the nucleonic, electric and neutrino charges are the only ones that are conserved. W. A. HEPNER

530.145

5291. Spin-spin and spin-other-orbit interactions. H. HORIE. *Progr. theor. Phys.*, **10,** 296–308 (*Sept.*, 1953).

Spin-spin and spin-other-orbit interactions are rewritten in terms of the products of tensor operators and the method of Racah is applied. The procedure has some advantages from the formal and the practical points of view. For example, the conjugation process can be carried out only after the decomposition of the spin-other-orbit operator into this form. It was confirmed that the magnetic interaction parameters are proportional to Z^3, Z being the atomic number. A.

530.145

5292. On the fundamental equation for the nucleon. T. OKABAYASHI. *Progr. theor. Phys.*, **10,** 499–504 (*Nov.*, 1953).

The validity of the assumption that nucleons satisfy the Dirac's wave equation does not appear to have been investigated. A possible direction for the modification of Dirac's equation for nucleons is proposed. A.

530.145

5293. On the relation of the masses proton-electron. S. YIFTAH. *C.R. Acad. Sci.* [*Paris*] **238,** 563–5 (*Feb.* 1, 1954) *In French.*

The reduction of the representation of the compound hydrogen system into the individual electron and proton representations gives the ratio of the proton to electron mass correctly. The method of Eddington is used. G. E. BROWN

530.145

5294. A new spinor theory of elementary particles. F. CAP. Letter in *Phys. Rev.*, **93,** 907 (*Feb.* 15, 1954).

In the work by the author and by H. Donnert, published elsewhere [Abstr. 3088–90 (1954)], Fierz's equations for free particles of spin s are replaced by ordinary second-order wave equations for spinors with indices of one kind only and with just $2(2s + 1)$ components to describe the spin and both signs of charge. Some possible advantages are pointed out. W. A. HEPNER

530.145

5295. Nonconservation of rest mass and the Dirac equation. L. MOTZ. Letter in *Phys. Rev.*, **93,** 901 (*Feb.* 15, 1954).

A generalized covariant form of the Hamiltonian of a Dirac particle is obtained by treating the rest mass and proper time of the particle as noncommuting, canonically conjugate, variables. The extra term in the Hamiltonian is interpreted as produced by instantaneous fluctuations of the rest mass. G. FIELD

530.145

5296. The classical interpretation of Dirac's theory of electron. K. C. KAR AND S. SANATANI. *Indian J. theor. Phys.*, **1,** 1–24 (*June*, 1953).

An attempt is made to explain Dirac's theory of the electron without the help of matrices. For the linearization of the relativistic Hamiltonian, a new method is given. From physical considerations four wavefunctions are assigned to describe the motion of an electron in a central field. Then, on taking wave statistical averages, the Hamiltonian at once becomes linear and the four linear wave equations are obtained without further assumptions. Matrices which "bring in" spin in Dirac theory are not used in this method and the spinning property of the electron is taken into account through the spin-orbit interaction energy in the Hamiltonian. The motion of a free electron is considered as a special case of the central field problem and 32 alternative sets of linear wave equations, all equally correct, are deduced in place of only one given by Dirac. A.

530.145

5297. On the connection between fields and particles. J. RZEWUSKI. *Acta phys. Polon.*, **11,** *No.* 3–4, 203–14 (1951–52).

The connection between field equations and equations of motion of particles is studied for the case of classical electrodynamics. The equations of motion and the energy and momentum of the particles

are derived from the corresponding notions for the field. The mass of the particle is purely electromagnetic and is uniquely determined either by the self-force or by the self-energy and self-momentum. Most of the results are independent of the structure of the particles. A.

530.145

5298. Classical derivation of the pseudoscalar interaction potential. K. C. KAR AND H. MUKHERJEE. *Indian J. theor. Phys.*, **1**, 67–72 (*Sept.*, 1953).

Following different methods, Bethe and Pauli have derived formulae for the interaction potential between two nucleons. Although the pseudoscalar part is the same in both, the scalar part is different in sign and magnitude. It is shown that both the formulae of Bethe and Pauli may be derived from purely classical ideas of doublet-doublet interaction. The assumption of inseparability of poles leads to the other. As, however, the idea of separability cannot be justified, Bethe's formula is preferable to that of Pauli. A.

530.145

5299. On the nuclear saturation. S. OGAWA AND T. MARUMORI. *Progr. theor. Phys.*, **10**, 265–74 (*Sept.*, 1953).

The Tamm–Dancoff method is applied to a bound system of many particles, from the view-point of meson theory. The results obtained seriously modify the usual method in which the many-body problem is treated with the simple addition of the two-body potential. It is shown that there is a possibility of obtaining the nuclear saturation by means of this modification. A.

530.145

5300. Effect of nucleon excited state on magnetic moment anomaly. T. HAMADA. *Progr. theor. Phys.*, **10**, 309–22 (*Sept.*, 1953).

Approximating a nucleon in its excited state by a spinor field with higher mass, charge and spin, its effects on the anomalous magnetic moment are estimated. The result for the spin-$\frac{3}{2}$ excited state is quadratically divergent leading to no definite conclusions. The contribution of the spin-$\frac{1}{2}$ and isotopic spin-$\frac{3}{2}$ excited state is positive for a proton and negative for a neutron if this state is of different parity from the normal state and vice versa if they are of the same parity, the absolute value being larger for proton in both cases. An additional interaction, which describes the transition of a nucleon up to or down from its excited state when it interacts with an external electromagnetic field, contributes nothing in the former choice of the parities while for the latter it gives an opposite contribution to proton and neutron. The effects are, after all, not large for a reasonable choice of coupling constant. A.

530.145

5301. Nuclear forces in pseudoscalar meson theory. I. SATO. *Progr. theor. Phys.*, **10**, 323–58 (*Sept.*, 1953).

Perturbation theoretical calculations are made of nuclear forces yielded by pseudoscalar meson theory up to the fourth order in the coupling constant, especially taking account of the recoil of the nucleons in the intermediate states. Both cases of pseudoscalar and pseudovector couplings are considered. The expressions of the nucleon-nucleon interactio obtained contain integrals of contributions of vario values of nucleon momenta in the intermediate stat Expanding the integrands of these integrals in powe of μ/M, and picking up the first few terms from ea of these expansions, the nuclear potentials for the ca in which the nucleon recoil is neglected are obtaine These potentials are found to be in agreement wi the adiabatic potentials which have been calculat by Taketani *et al.* for the case of pseudovect coupling, and by Lévy and Klein for the case pseudoscalar coupling. However, the differenc between the adiabatic potentials and the potentia calculated taking account of the nucleon recoil a found to be much larger than those expected takin them of higher order in μ/M. The qualitati properties of the nucleon-nucleon interactions ca culated are discussed.

530.14

5302. A remark on the strong coupling approxima tion in meson-nucleon scattering. Z. MAKI AN M. SATO. *Progr. theor. Phys.*, **10**, 386–98 (*Oct.*, 1953)

Tomonaga's intermediate coupling theory of meson nucleon scattering is applied to the case of stron meson-nucleon coupling, using the simplified mode of charged vector longitudinal mesons interactin with a heavy nucleon. The remarkable feature in th strong coupling limit is that, besides the ordinar levels of the nucleon, its isobars and their excite states, there exists another kind of excited level which plays an important role for the scatterin problem. The result agrees with the conclusions o the Wentzel's strong coupling treatment. Comparison with the case of the intermediate coupling region i discussed. A

530.14

5303. Pion-nucleon scattering and nucleon isobar A. KANAZAWA AND M. SUGAWARA. *Progr. theor Phys.*, **10**, 399–414 (*Oct.*, 1953).

The cross-sections for pion-nucleon scattering are calculated in symmetrical ps.-ps. and ps.-pv. theory assuming phenomenologically the effective interaction Hamiltonian which permits the virtual transitions o a nucleon to or from its excited state of spin and τ-spin $\frac{3}{2}$, which is described by the Rarita–Schwinger theory for spin-$\frac{3}{2}$ particles, accompanied by one pion emission or absorption. For ps.-ps. theory, the linear ps.-ps. coupling term is transformed into the sum of the equivalent pv. coupling term and the meson pair term, the coupling constant for the latter being chosen effectively small relative to that for the former, taking account of the strong, damping effect of nucleon pair formation. The basic equations are solved quite analogously to the well-known treatment of resonance fluorescence, in the approximation of neglecting nucleon recoils. In order to obtain the agreement of theoretical curves with experimental ones, the various coupling constants and the characteristic two adjustable parameters G and ΔE are determined quite sharply, G being the effective coupling constant determining the strength of virtual transitions to or from excited states and ΔE being the excitation energy of nucleon isobars. The determined values of the above coupling constants are quite reasonable and the satisfactory agreement

of the theoretical curves with the experimental ones is obtained for both types of coupling. It can be said, however, that the ps.-ps. coupling is rather preferable to ps.-pv. coupling, thus concluding that the symmetrical ps.-ps. theory can be considered to be satisfactory if appropriate account is taken of nucleon isobars; and the present model for isobars is also satisfactory, at least as far as the pion-nucleon scatterings are concerned. A.

530.145

5304. On the many-body problem in the intermediate coupling theory. I. T. Tati. *Progr. theor. Phys.*, **10,** 421–30 (*Oct.*, 1953).

The method of Matthews and Salam in the intermediate coupling theory is applied to the nuclear forces in the neutral PS.(ps.) meson theory. Static potentials are obtained, in one-pair approximations, including the damping effects of the pair coupling term. The *S*-wave probabilities in the meson cloud of the two-nucleon system are discussed. A.

530.145

5305. Many-body problem in quantum field theory. K. Nishijima. *Progr. theor. Phys.*, **10,** 549–74 (*Nov.*, 1953).

The Feynman–Dyson theory is extended so as to include scattering involving composite particles. For this purpose the relation of the Salpeter–Bethe wave functions to the probability amplitude has been clarified by introducing co- and contra-variant components of state vectors keeping a close correspondence to the vector analysis in an oblique coordinate system. The integral equations for various kinds of Feynman kernels are derived in a systematic way by making use of functional differentiations with respect to external source, and these equations are shown to have formal solutions expressed in terms of fermion kernels and various interaction operators. The procedure introduced by Gell-Mann and Low is fully utilized to derive integral equations for the covariant components with devices to take account suitably of the initial conditions. Finally the method of constructing the *S*-matrix is discussed. A.

530.145

5306. The symmetry relation of the *S*-matrix in the complex plane. N. G. van Kampen. *Physica*, **20,** 115–23 (*Feb.*, 1954).

For spherical scattering of a Schrödinger particle, it has previously been deduced from the "causality condition" [Abstr. 84 (1954)] that the *S*-matrix—as a function of the momentum p—is meromorphic in the right half of the complex p plane. A second condition is now added, namely, that the total energy has a lower bound. This new postulate makes an analytic continuation of $S(p)$ into the left half-plane possible. The values on the negative real axis satisfy the symmetry relation $S(-p) = S(p)^*$. A.

530.145

5307. On the derivation of the nuclear potential from the pseudoscalar meson theory. M. Jean. *C.R. Acad. Sci.* [*Paris*] **238,** 565–7 (*Feb.* 1, 1954) *In French.*

A Hamiltonian which is non-zero in the static approximation is obtained by a canonical transformation and treated in this approximation. Part of the interaction of the nucleons with the meson field is solved without perturbation theory by the method of Wentzel (1949) and the potential from the other part is obtained to fourth order in g, the meson-nucleon coupling constant. G. E. BROWN

530.145

5308. Ingoing waves in final state of scattering problems. G. Breit and H. A. Bethe. *Phys. Rev.*, **93,** 888–90 (*Feb.* 15, 1954).

See Abstr. 7903 (1953). The employment of the ingoing wave modification of plane waves is justified by a general argument. A.

530.145

5309. A non-perturbation treatment of scattering and the "Wentzel-Example." M. Cini, G. Morpurgo and B. Touschek. Letter in *Nuovo Cimento*, **11,** 316–17 (*March*, 1954).

The covariant method of Cini and Fubini [Abstr. 3121 (1954)] for treating scattering problems in field theory gives the accurate solution already in first approximation for this example. G. E. BROWN

530.145

5310. Multipole singularities of classical scalar and pseudoscalar meson fields. P. Havas. *Phys. Rev.*, **93,** 1400–11 (*March* 15, 1954).

The general form of the equations of motion of a particle possessing multipole singularities of a neutral scalar or pseudoscalar meson field has been found by Harish-Chandra on the basis of Dirac's method. In this paper the general form of the multipole moment compatible with these equations is established under the assumption that the spin and the 2^n-pole moments of the particle are of constant magnitude and have only spatial components in the system in which the particle is at rest. Then the general form of the equations of motion and of the multipole moment compatible with them is established for point particles interacting with a charge-symmetric scalar or pseudoscalar meson field. It is found that 2^n-pole moments of different types are possible for arbitrary n, and that a particle can carry an arbitrary combination of such moments. A.

530.145

5311. The problem of multiple scattering. E. P. Wigner. *Phys. Rev.*, **94,** 17–25 (*April* 1, 1954).

Multiple scattering can be regarded as a succession of elementary events. The distribution function for the particles which have gone through $n + 1$ elementary events is the convolution of two functions. The first of these expresses the scattering law; the second one is the distribution function for particles which have gone through n events. It is well known that such convolutions can be calculated very easily by means of Fourier transforms if the elementary event is the traversal of a free path in an arbitrary direction. In this case, the Fourier transform of the convolution is the product of the Fourier transforms of the convolvents. In the case of more general scattering laws, integrals over products of the distribution function, and of representations of the group which leaves the scattering law invariant, play the same role as the Fourier transforms play in the aforementioned case. From the present point of view, the exponential in the Fourier transform is a representation of the displacement group. It is shown that

one can solve several problems of multiple scattering on the basis of the above observation. These problems include the scattering of a point particle without change of energy but an arbitrary angular distribution, and several more involved problems. A.

530.145

5312. Configuration space methods for the construction of potentials. A. KLEIN. *Phys. Rev.*, **94,** 195–201 (*April* 1, 1954).

Methods proposed recently by Lévy and by Brueckner and Watson [Abstr. 4616 (1953)] for the construction of potentials in quantum field theory by superficially dissimilar techniques are rederived on a unified basis, that of the underlying equations in Fock space. It is supposed that certain amplitudes contained in the state vector are of primary physical interest, and it is demonstrated that the two methods differ essentially only in the order of elimination of the remaining amplitudes. The interpretation and practical use of the methods is discussed in a formal way, with emphasis on problems of consistency which limit the utility of the techniques. Elementary examples are discussed in the appendixes. A.

530.145

5313. Construction of a solution with mobile singularity of the equation $\Delta u - (1/c^2)(\partial^2 u/\partial t^2) = 0$. F. FER. *C.R. Acad. Sci.* [*Paris*] **238,** 567–9 (*Feb.* 1, 1954) *In French.*

The solution with a mobile linear singularity has a trajectory which obeys the de Broglie pilot wave equation. F. ANSBACHER

530.145

5314. Operators and observables in isotopic spin space. L. L. FOLDY. *Phys. Rev.*, **93,** 1395–400 (*March* 15, 1954).

The usefulness of the conventional isotopic spin formalism is somewhat marred by the fact that it contains superfluous formal elements which have no physical counterpart. It is demonstrated that application of the "superselection principle" for total electric charge, recently suggested by Wick, Wightman and Wigner, is sufficient to eliminate these superfluous elements and thus reduce the content of the theory to that of the more conventional formalism in which neutrons and protons are distinguished *ab initio*. This superselection principle applied to the conventional state-function representation of quantum mechanics requires that admissible state functions be eigenfunctions of the total charge and that operators representing observables commute with the total charge. The disjointness of the various subspaces in Hilbert space corresponding to different total charge eigenvalues, demanded by the superselection principle, leads to the result that many observables which are outwardly different in form are actually essentially equivalent. The construction of all inequivalent observables compounded from nucleonic isotopic spin operators only is carried out and it is shown that all such observables are simply functions of the square of the total isotopic spin and its z component. The essentially unique character of the charge parity operator introduced by Kroll and Foldy is established. A.

530.145 : 530.1

5315. On the microstructure of the world. I. The elementary length. J. WEYSSENHOFF. *Acta phys. Polon.*, **11,** *No.* 3–4, 273–97 (1951–52).

The main causes of the difficulties encountered by present-day physics in the theory of elementary particles is attributed to (i) the indiscriminate use of Euclidean (or pseudo-Euclidean) metric both in microphysics and macrophysics, and (ii) the recognition of the point (or the point-event) not only as the primitive notion of macrophysics but also of microphysics. An attempt is made to construct such a scheme of macro-micro-macrophysical space-time measurements which leads to Euclidean geometry only in macrophysics, this geometry ceasing to be even approximately valid in microphysics. This can be achieved by changing the primitive element of physical geometry from the point to that of "directed wave front" and by adopting the "concordant contact" of two wave fronts as their unique primitive relation. If the proposed theory proves to be true, then all laws of microphysics will have to be invariant under the 15-parameter group of wave-front transformations, which is isomorphic with the 15-parameter group of Lie's sphere transformations in three-dimensional space (or the Möbius group of conformal point-transformation in four-dimensional space). At the same time the concept of elementary length is automatically introduced in the foundations of physics. A.

530.162

5316. Distributions and statistical moments of bosons and fermions with some of their applications. J. ŁOPUSZAŃSKI. *Acta phys. Polon.*, **11,** *No.* 3–4, 298–313 (1951–52).

Contains a sketch of an analytic method of solving combinatory problems concerning the distribution of particles into cells, the particles being either distinguishable or not and the different possibilities of filling the cells being possibly subject to *a priori* given restrictions. This method rests upon the use of so-called Laplace's generating functions. The fundamental generating function as well as the characteristic function of a generating function have been defined and Newton's polynomial expansion applied to the generating functions. Distributions of probabilities as well as their statistical moments have been obtained. Also application of the above method to problems in cosmic radiation, the theory of contrast in photographic emulsions, and the theory of number have been given. A.

530.162

5317. Degenerate gas and the motion of a particle in a harmonic field. J. S. BAIJAL AND R. CHANDRA. *Proc. Nat. Inst. Sci. India,* **19,** 423–6 (*May–June*, 1953).

The density distribution of a degenerate Fermi–Dirac gas in a uniform field of force has been discussed by Kothari and Auluck (1942). In the present paper a similar problem is considered where the field of force is not uniform but its gradient is constant. The density distribution is first obtained with the help of Gibbs free energy for degenerate gas. It is obtained directly by solving the wave equation for a particle moving in a constant-gradient field and subject to

proper boundary conditions. The generalization of the result to more than one dimension is discussed in the last section. A.

530.162

5318. Bose–Einstein condensation and the partition theory of numbers. V. S. NANDA. *Proc. Nat. Inst. Sci. India*, **19**, 681–90 (*Sept.–Oct.*, 1953).

The thermodynamics of a Bose–Einstein assembly, with equidistant energy levels, is investigated by the rigorous methods of analytic theory of partitions in order to check the results obtained by the orthodox formula. Such an investigation has become necessary due to a demonstration by Schubert of the failure of the "saddle-point method" in the degenerate Bose–Einstein case. The results obtained here may be regarded as an extension of the work begun by Temperley [Abstr. 739 (1950)] (though the conclusions drawn are in many ways different) who has shown that the orthodox distribution formula is valid only at very high and very low temperatures but fails completely for the intermediate temperatures. He also doubted the validity of the assumption about the identity of the mean state and the most probable state for the present model. Temperley, however, did not give an expression for the mean state. An exact expression is now obtained for the mean state and it is shown that this agrees with the most probable state in the limit of a very large assembly. Further, it is proved that besides the condensation value given by Temperley there are two other values, depending on the definition used, at which condensation can be supposed to occur. It is also noticed that the orthodox distribution formula gives results which are correct to a first approximation even in the transition region. A.

530.162

5319. Quantum statistics of closed and open systems. P. T. LANDSBERG. *Phys. Rev.*, **93**, 1170–1 (*March* 15, 1954).

In this note an ideal Bose–Einstein and an ideal Fermi–Dirac gas are considered in the "limit L," i.e. in the limit in which the number of particles N and the volume V of the system are allowed to tend to infinity so as to keep N/V a finite and non-zero constant. It is shown that, whatever the system of energy levels, the mean occupation numbers calculated on the basis of the grand canonical ensemble are in the limit L the same as those calculated on the basis of the canonical ensemble. The only requirement is that the mean total number of particles for the grand canonical ensemble be equal to the fixed total number of particles for the canonical ensemble. A.

GENERAL MECHANICS MECHANICS OF SOLIDS 531

531.25

5320. The equations of compatibility and stress functions in tensor form. M. BRDIČKA. *Czech. J. Phys.*, **3**, 36–52 (*March*, 1953) *In Russian.*

In this paper some new use of the tensor calculus in elasticity is given, concerning principally the equations of compatibility and the integration of the equation of equilibrium by means of the stress functions. There is a 200-word summary in English, with numerous references to the mathematical expressions in the Russian text. A.

531.258

5321. Stress distribution in an infinite plate with an elliptic hole acted upon by a force and a couple at an internal point. B. KARUNES. *Indian J. Phys.*, **27**, 439–46 (*Sept.*, 1953).

The function theoretical method of Muschelisvili (1933) for solving two dimensional problems in elasticity is employed to obtain solutions of the problems of stress distribution in a large plate containing an elliptic hole under the action of an isolated force or a couple at any point inside the plate. From these solutions particular cases of the force and couple acting on the boundary of the hole are derived and the results are compared with those obtained by Rothman (1950), who used complex potentials as introduced by Stevenson (1945). A.

531.53

5322. Rectangular plate pendulum. I. M. FREEMAN. *Amer. J. Phys.*, **22**, 157–8 (*April*, 1954).

A uniform rectangular plate is arranged so that it oscillates in its own plane around either one of two axes, one at the centre of each edge. The analysis shows that there is a particular ratio of the lengths of the two sides (in addition to unity) for which the two periods are equal, and still another ratio giving the minimum period. These computations check satisfactorily by experiment. A.

MECHANICAL MEASUREMENTS 531.7

531.717 : 539.165

The best performance with β-ray thickness gauges. *See Abstr.* 5924

531.787.9

5323. A piezo-electric recording manometer. S. N. A. MARGERSON AND H. ROBINSON. *Safety Mines Res. Establ. Res. Rep. No.* 82, 33 *pp.* (*Dec.*, 1953).

The manometer has been designed for measurements in rapidly developed explosions. It combines high sensitivity with a long time constant. A.

MECHANICS OF FLUIDS 532

532.13

5324. On an indeterminate integral in Einstein's theory of the viscosity of a suspension. M. MOONEY. Letter in *J. appl. Phys.*, **25**, 406–7 (*March*, 1954).

Since no particle of radius (a) can have its centre located within a sphere of radius (a) about a point in the liquid, this space of radius (a) must be excluded from the range of integration. The integral in question is the sum of the perturbations due to all the particles in the liquid and vanishes on the above

argument if the outer range of integration is a large sphere, as Einstein takes. Conditions for non-zero values are discussed. T. C. TOYE

532.13 : 532.72

5325. On the viscosity and the self-diffusion in liquids. S. PETER. *Z. Naturforsch.*, **9a**, 98–104 (*Feb.*, 1954) *In German.*

A liquid model theory is proposed and a formula developed for the calculation of melting point viscosities. Good agreement is obtained for a considerable number of organic liquids and also for four liquid metals. T. C. TOYE

532.13 : 536.432.15

5326. Relation between vapor pressure and viscosity of liquids. S. S. MITRA. Letter in *J. chem. Phys.*, **22**, 349–50 (*Feb.*, 1954).

Log p is a linear or quadratic function of log η along the vaporization curve. R. O. DAVIES

532.137

5327. A coaxial cylinder viscometer for the study of fluids under high velocity gradients. E. W. MERRILL. *J. Colloid Sci.*, **9**, 7–19 (*Feb.*, 1954).

A coaxial cylinder viscometer is described for the absolute measurement of shearing stress v. velocity gradient up to high values of gradient. Principal features of construction are: bottomless cylindrical shearing surfaces, very small annular clearance, rigid mechanical alignment of the cylinders, and a pressure-feeding system. Several advantages are thereby achieved, not found together in other cylindrical viscometers: (1) versatility in testing a wide range of viscous fluids, including gels; (2) measurement of shearing stress and corresponding velocity gradient as essentially point values; (3) variability of velocity gradient up to high values; (4) good control of fluid temperatures; and (5) ease of introduction of fluids for test. Typical experimental results are presented for viscous Newtonian fluids, a commercial paint, and a varnish. A.

532.517

5328. On small disturbances of plane Couette flow. W. WASOW. *J. Res. Nat. Bur. Stand.*, **51**, 195–202 (*Oct.*, 1953).

The Orr–Sommerfeld equation for the function $\phi(y)$, which appears in the component $\phi(y) \exp\{i\alpha(x - ct)\}$ of the stream function, is analysed in detail for the case of plane Couette flow. A set of solutions is found whose asymptotic behaviour as $\alpha R \to \infty$ can be calculated in the whole complex y-plane (R is the Reynolds number). A disturbance with given α is proved stable, for any α, if αR is sufficiently large. In addition, an investigation is made of the asymptotic properties of an allied equation for which, in contradistinction to the singular Couette case, an inner friction layer does exist. A.

532.517 : 532.133

5329. Oscillation of viscous liquids in tubes and the criterion of stream line motion. S. VENKATARAMAN. *Indian J. Phys.*, **27**, 452–6 (*Sept.*, 1953).

The problem of oscillation of liquids in cylindrical tubes is investigated. It is found that the logarithmic decrement $\frac{1}{2}\nu k^2 T$, where $k = 1{\cdot}2197\,\pi/a$, can be used to determine the viscosity of the liquid. It is also found that for streamline flow the radius of the tube must be such that the number $a^2/\nu T$ (where T is the periodic time), must lie between 5 and 37. By this method the viscosities of fairly viscous liquids, viz. the higher alcohols, were determined and the values thus obtained agree well with the standard values given in International Critical Tables. A.

532.52

5330. Vibrations as a cause of disintegration in liquid sheets. R. P. FRASER, N. DOMBROWSKI AND P. EISENKLAM. Letter in *Nature* [*London*] **173**, 495 (*March* 13, 1954).

A study of the disintegration of liquid jets by a pressure-atomiser shows that the liquid first forms a thin sheet which disintegrates away from the nozzle, the disintegration being influenced by the properties of the liquid, the nozzle and the surrounding atmosphere. In some cases, holes are formed in the sheet and these expand rapidly. The holes can be caused by the presence of non-wettable particles in the liquid or by turbulence. With liquid jets, turbulent, unsteady flow behind the nozzle is a primary cause of jet disintegration. The frequency of ripples observed in the sheet is of the order 10 kc/s. J. S. G. THOMAS

532.582.7

5331. Motion of small particles in skew shape suspended in a viscous liquid. C.-M. TCHEN. *J. appl. Phys.*, **25**, 463–73 (*April*, 1954).

The resistance experienced by a curved and elongated small particle is studied by the method of velocity perturbations. The fundamental equations determining the perturbations are derived from the equations of Oseen. The particle is curved in such a way that the axis of the particle is formed by an arc of circle. The opening angle may vary to exhibit various shapes from a straight ellipsoid to a closed ring. Results illustrate the circumstances under which manifests the co-operation between the different parts of the particle. Apart from this pure hydrodynamical interest, the problem has applications to long chain molecules in solution and to suspensions of swimming organisms. It demonstrates the effect of skew shape by taking for the chain molecule a model in the form of a variable-curved ellipsoid instead of a sphere or a cluster of spherical symmetry, as the co-ordination of the chain links, even in the case of free rotation, leads initially to configurations of variable skewness generally obscured under the averaging processes by current theories. A.

532.593 : 551.515

5332. Storm location at sea—an illustration of group velocity. E. MENDOZA. *Amer. J. Phys.*, **22**, 208–11 (*April*, 1954).

When the waves from a storm at sea travel outwards, the long waves arrive first at any distant fixed point and are succeeded by shorter and shorter ones. Observation of the wavelength of the arriving train as a function of time determines the distance away of the storm centre. A description of the phenomenon involves an account of the progress of an arbitrary disturbance in a dispersive medium, and it is suggested that this might prove an interesting illustration for teaching purposes of the concept of group velocity. A.

532.595

5333. Oscillation of mercury in a U tube. The influence of capillarity. A. HUETZ AND J. HUETZ. *C.R. Acad. Sci.* [*Paris*] **238,** 768–70 (*Feb.* 15, 1954) *In French.*

Experimental observations show that classical theory is obeyed only at large amplitudes.

T. C. TOYE

CAPILLARITY 532.6

532.623

5334. The life of single bubbles on water. F. H. CONSTABLE AND S. BAYKUT. *Rev. Fac. Sci. Univ. Istanbul A,* **17,** 309–21 (*Oct.*, 1952).

The bubble lives are subject to large variations even when the bubble volume is fixed. The standard deviation (σ) was little less than the mean life. But the value of $\sigma = \sqrt{\frac{\Sigma(t - t_m)^2}{(n-1)(n)}}$ for the mean of 100 observations was only a small fraction of the mean life, so that it was possible to work with mean observations. The relation between mean t and volume of bubble was $t = v^{\frac{1}{3}}/(A + Bv^{\frac{2}{3}})$, where $A = 0{\cdot}0285$, $B = 0{\cdot}4592$, and σ could be calculated. To avoid the increase in t due to single large bubbles of long life the work was repeated using the most frequent life of a grown bubble. The same general formula seemed to be applicable with different constants. A.

532.623

5335. Mechanism of the bursting of bubbles. F. KNELMAN, N. DOMBROWSKI AND D. M. NEWITT. *Nature* [*London*] **173,** 261 (*Feb.* 6, 1954).

High-speed photographic records show that when a gas or vapour bubble bursts at the surface of water the thin upper surface disintegrates into a cloud of very fine droplets which are then blown away by the egress of gas through the gap in the envelope. The inrush of water into the crater thus formed produces an unstable jet which breaks up into one or more large drops of about 1 mm diameter. T. C. TOYE

532.68

5336. Exchange of liquid between paper pores. D. TOLLENAAR. *Appl. sci. Res. A,* **3,** *No.* 6, 451–61 (1953).

The capillary rise of liquid in paper cannot be explained quantitatively by assuming uniform capillaries. The introduction of a distribution function for the capillary radii offers the possibility of calculating a correction term for the capillary pressure and the volume of liquid at any level. A.

532.692

5337. Simple experiment showing the existence of "liquid water" film on the ice surface. U. NAKAYA AND A. MATSUMOTO. *J. Colloid Sci.,* **9,** 41–9 (*Feb.*, 1954).

Two small ice spheres are suspended by thin cotton filaments. The top of one filament is displaced horizontally by a screw motion. The movable ice sphere is brought in contact with the stationary sphere, and then the screw is turned back. The normal cohesion is measured by the inclination of the filament when the spheres are separated. Sometimes the ice spheres showed a rotation before separation. The rotation took place more frequently in the range of temperatures near the freezing point, but it was observed once at $-7{\cdot}0$°C, the lowest temperature when distilled water was used. When ice spheres made of 0·1% solution of NaCl were used, this rotation was very likely to occur and was observed quite often at -14°C. Successive rotations were sometimes observed in this case. These phenomena are explained by considering a model of the point of contact, which is composed of a solid ice bond and surface films of a liquid-like nature. The relation between the strength of the ice bond and the area of contact is calculated by using Hertz's equation. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7 : 539.266

5338. X-ray diffraction in liquid sulfur. J. A. PRINS. *Physica,* **20,** 124–8 (*Feb.*, 1954).

The diffraction pattern of liquid sulphur from 100° to 340°C, using Mo radiation, is found to have maxima at 5·5, 3·6, 1·72 and 1·03 Å Bragg spacing. The positions are almost independent of temperature; the intensity of the inner maximum (at 5·5 Å), however, is enhanced with increasing temperature. It is shown that this effect may account for the apparent shift of the "principal maximum" recorded by Blatchford and by Gingrich. The crystallization at slow and at sudden cooling is studied. A.

532.72

5339. Action of ultrasound on diffusion-controlled heterogeneous processes. N. N. DOLGOPOLOV, V. M. FRIDMAN AND N. M. KARAVAEV. *Dokl. Akad. Nauk SSSR,* **93,** *No.* 1, 93–5 (1953) *In Russian.*

Ultrasound considerably increases the rate of dissolution of a crystal of $K_3Fe(CN)_6$ in water, and of Cu in HNO_3, even above the rate attained at high rates of rotation (1200 r.p.m.) of the dissolving body.

R. C. MURRAY

532.72

5340. Action of ultrasonic vibrations on diffusional processes. N. N. DOLGOPOLOV, V. M. FRIDMAN AND N. M. KARAVAEV. *Dokl. Akad. Nauk SSSR,* **93,** *No.* 2, 305–6 (1953) *In Russian.*

Ultrasound increases the diffusion constant of copper sulphate into gelatine from $0{\cdot}6\times10^{-4}$ to $0{\cdot}8\times10^{-4}$, and of thiosulphate through a gelatine film from $8{\cdot}6\times10^{-4}$ (with vigorous stirring) to $11{\cdot}7\times10^{-4}$. R. C. MURRAY

532.72

5341. Self-diffusion in liquid indium. G. CARERI, A. PAOLETTI AND F. L. SALVETTI. *Nuovo Cimento,* **11,** 399–406 (*April*, 1954).

The self-diffusion coefficient of liquid indium has been measured in the range from 160 to 480°C with

results which are very close to the ones for liquid mercury. Near the melting point some complications occur, which are discussed in terms of crystallite formation. A.

532.77 : 539.133

On abnormally small lengths of chain molecules in solution. *See Abstr.* 5865

MECHANICS OF GASES 533

533.15

5342. Transport properties of some gas mixtures. M. P. MADAN. *Proc. Nat. Inst. Sci. India*, **19**, 713–19 (*Sept.–Oct.*, 1953).

Utilizing the intermolecular force constants obtained from thermal diffusion data in conjunction with the theoretical relations connecting these constants for like and unlike molecules developed by the authors [Abstr. 3015 (1953)], the transport properties, viz. the coefficients of viscosity and inter-diffusion for a number of binary gas mixtures have been calculated and compared with the experimental results. It is found that the agreement between the theory and experiment is quite satisfactory. A.

533.16

5343. Viscosity of gaseous He^3 and He^4 between 1·3° and 4·2°K. E. W. BECKER, R. MISENTA AND F. SCHMEISSNER. Letter in *Phys. Rev.*, **93**, 244 (*Jan.* 1, 1954).

These measurements, which also include He^3–He^4 mixtures, agree at 4·2°K with the theoretical prediction by de Boer and Cohen [Abstr. 1528 (1952)]. At 1·3°K the experimental value for He^3 is 12% lower. H. LONDON

533.5

5344. A design of pressure/vacuum valve. F. L. SPEED. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. ED/R* 1302, 2 *pp.* (1953).

A design of pressure/vacuum isolation valve which has operated very satisfactorily in the inert gas lines of experimental liquid metal circuits. Sealing of the seat and gland is achieved by sliding "O" rings resulting in a compact simple construction which requires little maintenance and no gland packing adjustment. A.

533.5 : 531.788

5345. An absolute vacuum gauge. Z. TROUSIL. Letter in *Czech. J. Phys.*, **2**, 146–8 (1953) *In Russian.*

The gauge, which is a modified, very sensitive version of the Bačkovský–Kunzl manometer, has a range of 10^{-6} to 1 mm Hg and is particularly suitable for measuring the vapour pressure of easily condensable liquids. A. GELBTUCH

533.5 : 531.788

5346. Some experiments with a cold-cathode vacuum gauge. K. PHILLIPS. Note in *J. sci. Instrum.*, **31**, 110–11 (*March*, 1954).

Experiments on a Penning type gauge at voltages up to 12 kV are described. It was found that instabilities were not noticed at fields of around 1600 gauss but were observed at 600 gauss. T calibration is independent of cathode material a this may be due to a thin layer of cracked pu oil. A. H. W. BE

533.5 : 531.7

5347. A thermistor McLeod gauge for a pressu range $1–10^{-7}$ mm of mercury. R. S. BRADL *J. sci. Instrum.*, **31**, 129–30 (*April*, 1954).

A gauge capable of reading pressures of nc condensable gases in the range $1–10^{-7}$ mm Hg h been made by sealing a thermistor bead into the e of the closed capillary of a McLeod gauge, t thermistor acting as a thermal conductivity man meter of the Pirani type.

533.5 : 531.788

5348. Notes on the ionization gauge. L. RIDDIFOR Note in *J. sci. Instrum.*, **31**, 111 (*March*, 1954).

See Abstr. 1536 (1952). The values 1·22 a 1·34 for dry air and nitrogen given previously shou be revised to 0·82 and 0·75. A. H. W. BEC

533.5 : 531.788

5349. An ionization manometer and control unit f extremely low pressures. P. A. REDHEAD AND L. McNARRY. *Canad. J. Phys.*, **32**, 267–74 (*April*, 1954

A Bayard–Alpert type ionization manometer f the measurement of pressures as low as 10^{-10} mm mercury is described, and methods for increasing t sensitivity are discussed. The control unit is dire reading in pressure to 10^{-10} mm and has provisio for degassing the electrodes. A

533.5

5350. An automatic Töpler pump. W. J. ARRO AND E. J. WILSON. *Atomic Energy Res. Estab* [*Harwell*] *Mem. I/M*30, 2 *pp.* + ii *pp.* (1953).

The construction and performance of a Pyrex glas automatic Töpler pump for use in high vacuu apparatus is described. A

533.6.011.

5351. The reduction of choked jet noise. A POWELL. *Proc. Phys. Soc.* [*London*] *B*, **67**, 313–2 (*April*, 1954).

Some methods of reducing that noise peculiar t choked jets are investigated, the mode of operation being a reduction of one or more of the factor occurring in the gain criterion $q\eta_s\eta_t\eta_d \geqslant 1$, in the notation of Abstr. 1114 (1954). The methods use consist of the notching of the exit edge of the je nozzle, the introduction of cambered radial vanes an ventilation of the nozzle by means of a gauze extension The magnitude of the noise of a jet emanating from a plain exit is shown to be susceptible to the state of the exit edge and the reflecting area presented by the nozzle body in the plane of the exit. It is suggested that the presence of initial turbulence or noise will also tend to reduce the magnitude of the sound, and this effect may be of importance in the practical case of the jets of propulsive mechanisms. The methods used influence other types of noise always present to some degree, a measured reduction in actual subsonic noise only being found in the case of the radial vanes. A.

MOLECULAR THEORY OF GASES 533.7

533.7

5352. Solution of Boltzmann equation for Maxwellian molecules. E. P. GROSS. Letter in *Phys. Rev.*, **3**, 347 (*Jan.* 15, 1954).

Preliminary announcement of a new iterative method applicable only with an inverse fifth power repulsive force law. R. O. DAVIES

533.75 : 536.44

Thermodynamic properties of xenon in the critical region. *See Abstr.* 5550–1

VIBRATIONS . ACOUSTICS 534

534.112

5353. On the velocity of vibration of strings of gut wound with metal wires. B. BLADIER. *C.R. Acad. Sci.* [*Paris*] **238**, 570–2 (*Feb.* 1, 1954) *In French.*

A brief description is given of an investigation of the mechanical vibration of about 30 strings of gut wound with metal wires of aluminium, silver and of tungsten (like lower C string of a cello 66 c/s). The strings had an effective length of 704 mm between bridge and nut, and were set into vibration by a circular bow of ebonite 600 mm circumference and 12 mm wide. The displacement velocity of the string was recorded by two methods: (1) capacity changes, and (2) induced e.m.f.'s in a magnetic field. This method is preferable to displacement measurement as it reveals more clearly the presence of the higher overtones which sometimes attain appreciable velocities. Comparative records show the effect of winding the strings with Al, Ag or W wires.

A. B. WOOD

534.121.1

5354. On axi-symmetrical vibrations of circular plates of uniform thickness; including the effects of transverse shear deformation and rotatory inertia. E. REISSNER. Letter in *J. Acoust. Soc. Amer.*, **26**, 252–3 (*March*, 1954).

Starting from the differential equations for axi-symmetrical transverse vibrations of homogeneous plates, it is shown how the solution may be expressed in terms of Bessel functions. When transverse shear deformation and rotatory inertia are neglected, the solution reduces to that of Kirchhoff. H. J. H. STARKS

534.13 : 532.65

5355. Vibrations of evaporating liquid drops. N. J. HOLTER AND W. R. GLASSCOCK. Letter in *J. Acoust. Soc. Amer.*, **26**, 253 (*March*, 1954).

See Abstr. 670 (1953). Acknowledgment of earlier work.

534.13 : 534.232

5356. Note on longitudinal vibration amplitudes of solid conical horns. R. H. QUINT. Letter in *J. Acoust. Soc. Amer.*, **26**, 252 (*March*, 1954).

An equation is given for the amplitude multiplication factor of a longitudinally vibrating solid resonant cone; showing, that from simple theory, as one of the diameters reduces to zero, the amplitude multiplication factor remains non-zero. A.

534.13 : 539.214.9

5357. Dynamics of plastic deformations in a bar exhibiting strain-rate effect and subjected to alternating stresses. S. K. GHOSH. *Indian J. Phys.*, **27**, 541–6 (*Nov.*, 1953).

The dynamics of the vibration of a bar exhibiting strain-rate effect when subjected to an alternating mechanical stress has been worked out, following the operational method. An expression for the amplitude of vibration at the free end in terms of resonance frequency and fractional detuning at 3 db point has been derived. An accurate formula is also derived for the resonance frequency. An expression giving the displacement at any point along the bar has also been derived. The work of previous authors is critically discussed. A.

534.133 : 621.372.412

5358. Fundamental extensional mode of circular quartz plates. E. KLIER. *Czech. J. Phys.*, **3**, 72–84 (*March*, 1953).

The paper describes a new mode of vibrations found on YΘ-cut quartz plates which can be used for the control of oscillators. It is possible to find an orientation in which this mode has zero temperature coefficient of frequency. A.

534.133 : 621.372.412

5359. Simultaneous oscillations of a quartz crystal at various frequencies. K. G. SRIVASTAVA. *J. sci. industr. Res.*, **12 B**, 393–5 (*Sept.*, 1953).

Diffraction of light produced by an ultrasonic wave in benzene, toluene, chloroform, carbon tetrachloride and xylene has been studied with the help of a Y-cut crystal and a Hartley oscillator. Under certain conditions the diffraction patterns reveal a number of crystal frequencies whose number, intensity and sharpness vary with the liquid studied. The results obtained are explained by considering that the resonance curve of the oscillator is broadened out and that the crystal absorbs power at its various frequencies which fall within its range. The greatest amount of broadening is observed in the case of xylene although its conductivity is the least, thereby showing that conductivity is not the only factor which leads to the broadening of the oscillator frequency. A.

534.141.3

5360. Bowing of violin strings. J. B. KELLER. *Commun. pure appl. Math.*, **6**, 483–95 (*Nov.*, 1953).

A theory of the forced motion of a string acted upon by a bow is presented. Solutions of the resulting equations show, in agreement with experiment, that (i) the character of the string motion depends only upon the ratio of bowing velocity to bow pressure, while the string velocity at each point, and therefore the amplitude, is proportional to bowing velocity, (ii) the velocity of the bowed point on the string is piecewise constant both during the forward and the return motions, and (iii) the velocity of the string at every point is piecewise constant and the string shape is piecewise linear. As opposed to Friedlander [Abstr. 8280 (1953)], the author assumes that the friction curve, which must be known for applying the theory, increases as the relative velocity increases.

A. GELBTUCH

534.141.4

5361. Self-maintained oscillations of the jet in a jet-edge system. I. W. L. NYBORG. *J. Acoust. Soc. Amer.*, **26**, 174–82 (*March*, 1954).

A theory is presented for the self-maintained transverse oscillations which arise in a low-velocity jet as it plays upon an obstacle, thus generating edge tones. It is assumed that transverse forces act on each particle of the jet as it travels toward an obstacle, and that this force is due to "sources" of hydrodynamic origin localized near the obstacle. The law of motion is set up in the form of an integral equation involving unknown functions for the force field. It is shown that a number of important properties of jet-edge systems, and of the edge tones they produce, can be deduced from the equation, even for highly simplifying trial assumptions about the unknown functions. A.

534.2

5362. Waves of finite amplitude in an infinite homogeneous medium. H. L. HELFER. *Astrophys. J.*, **119**, 34–41 (*Jan.*, 1954).

The existence of a particular class of finite waves in an infinite homogeneous medium when the gravitational effect of the fluctuation is included is demonstrated. Stationary, progressive and solitary waves are all permitted solutions. It is shown that the Jeans critical length, valid for determining the maximum wavelength of stable infinitesimal density fluctuations, adequately represents the effective lengths of these disturbances, provided that the development of the density fluctuations is always along the same adiabatic. Departure from this requirement, as, for example, in the occurrence of shock waves, may result in stable fluctuations of dimensions considerably in excess of the Jeans criterion. A.

534.21

5363. Wave propagation in a randomly inhomogeneous medium. III. D. MINTZER. *J. Acoust. Soc. Amer.*, **26**, 186–90 (*March*, 1954).

For Pt II, see Abstr. 3202 (1954). The coefficient of variation for a series of sound pulses and the correlation function for successively received sound pulses are evaluated for arbitrary pulse length, using the assumption that the correlation function of the refractive index inhomogeneities is expressible as the product of time- and space-dependent functions. For the case of pulse length much less than the time constant of refractive index correlation function, the coefficient of variation is found to be independent of the pulse length, and the pulse-correlation function is found to be identical with the time-dependent part of the refractive index correlation function. Comparison is made with data obtained from Sheehy. An approximate calculation shows that the motion of source and receiver will distort the pulse-correlation function so that little information can be obtained from the data concerning the time dependence of the refractive index. A.

534.213.4

5364. Finite amplitude sound produced by a piston in a closed tube. J. B. KELLER. Letter in *J. Acoust. Soc. Amer.*, **26**, 253–4 (*March*, 1954).

The problem stated in the title is solved for a gas with $\gamma = -1$ by the method of a previous paper. First an arbitrary piston motion is considered. T more detailed results are given for the sinusoidal c See Abstr. 3038 (1953).

534.213.4 : 534

5365. On the theory of sound reflection in an op ended cylindrical tube. H. LEVINE. *J. Acoust. S Amer.*, **26**, 200–11 (*March*, 1954).

The propagation of dominant mode plane sou waves within a cylindrical tube having arbitrary cr section and extending indefinitely from an open e is studied theoretically. A quantity of special inter is the end correction, which characterizes the reflecti coefficient at wavelengths large compared with transverse tube dimensions. The reflection coefficie and end correction fit naturally into a boundary va formulation of the wave propagation problem, wh solution hinges on that of one or more integ equations. Since the integral equations do not general admit of exact solution, practical techniqu for approximately determining the physical quantit are important. Among these are the stationary variational principles, which can be cast into a varie of independent forms, corresponding to the differe nature of boundary distributions. Another techniq is based on initial modification of an integral equati so as to utilize the possibility of explicit and rigoro solution. Approximate forms of the reflecti coefficient and end correction are obtained in th manner, with the distinction of yielding exact resu when the tube cross-section is circular. A bri comparison of the different procedures is included.

534.2

5366. Measurement of ultrasonic velocities in som Indian rocks. M. KRISHNAMURTHI AND S. BAL KRISHNA. *Proc. Indian Acad. Sci. A*, **38**, 495–50 (*Dec.*, 1953).

The phenomenon of total internal reflection w employed in developing a technique for measuring th ultrasonic velocities in solids using pulsed ultrason beams. The ease and accuracy with which the critica angles can be measured make this method superio to other methods in some respects. Besides th longitudinal velocities, torsional velocities were als measured in a number of Indian rocks for the firs time. It is essential to use fairly large sized sample in this method. An earlier observation indicating dependence of sound transmission on granular textur of the rocks has been confirmed qualitatively in thi investigation. A

534.2

5367. Sound velocity in some aqueous solutions as function of concentration and temperature. R BARTHEL. *J. Acoust. Soc. Amer.*, **26**, 227–30 (*March* 1954).

Precision sound velocity measurements are reporte in sucrose solutions in the concentration range up to 3 molal, and in solutions of NaCl and $Pb(NO_3)_2$ up to 2 molal. Measurements were made at three temperatures—24·76°c, 40·37°c and 59·60°c—using 15 Mc/s sound. For sucrose and NaCl the velocity v molality relation is linear out to about 1 molal, where a slight decrease in slope sets in. For $Pb(NO_3)_2$ the velocity v. molality relation has a negative slope, and a rise from linearity is already evident at 0·5 molal.

A simple theory of the concentration dependence of the sound velocity in solutions is developed and correlated with experimental data. A.

534.22

5368. The dispersion of the velocity of sound in water between 500 and 1500 kilocycles. T. K. McCubbin, Jr. *J. Acoust. Soc. Amer.*, **26**, 247–9 (*March*, 1954).

Dispersion of the velocity of sound was measured by simultaneously transmitting continuous trains of sound waves of the two frequencies through water. One transducer was used to generate the two signals and a second transducer, which could be moved in the direction of the sound beam, received the signals. Dispersion was determined by measuring the change in the relative phase of the two received signals as the length of path between the transducers was varied. These measurements indicated that the velocity of sound at 500 kc/s was equal to the velocity at 1500 kc/s to within one part in 290 000. A.

534.22

5369. The effect of slip on sound propagation. D. E. Weston. Letter in *Proc. Phys. Soc.* [*London*] *B*, **67**, 265 (*March*, 1954).

Draws attention to a paper by Caro and Martin on the propagation of sound in tubes at low pressure [Abstr. 164 (1954)] and points out that there are two factors which they do not take into account, viz. second-order tube correction and velocity slip at the wall. A correction to the Caro–Martin velocity-pressure expression is suggested to allow for these factors. A. B. WOOD

534.22 : 532.7

5370. A further elucidation of the relationship between sound velocity in liquids and molecular weight. S. Parthasarathy and N. N. Bakhshi. Letter in *Nuovo Cimento*, **11**, 310–11 (*March*, 1954).

Regular behaviour for a large number of liquids of different homologous series was found previously [Abstr. 6557 (1953)]. Continuation of the work shows that at very high molecular weight in homologous series the velocity of sound is independent of molecular weight. T. C. TOYE

534.222.2 : 537.56

5371. The electrical conductivity of shock- and detonation-waves, and the measurement of the velocity of the waves. M. Birk, A. Erez, Y. Manheimer and G. Nahmani. *C.R. Acad. Sci.* [*Paris*] **238**, 654–5 (*Feb.* 8, 1954) *In French.*

When a detonation wave traverses an explosive it creates a very high density zone of ions; this is utilized to close an electric circuit and indicate the passage of the detonation wave front; a similar phenomenon characterizes aerial shock waves sufficiently powerful to generate a density of ions sufficient to permit electric conduction. The part played by the surface of the electrodes and the intensity of the shock wave in the conduction has been studied by placing electrodes either in or near the explosive, and measuring the electrical conductivity by an oscillograph. It is considered that the fact that, in the explosive, the current intensity is a linear function of the p.d. justifies the introduction of the notion of an "ionization resistance." An increase of the electrode surface causes a decrease of this resistance, and a closer approach of the electrodes causes an increase of the current intensity. Shock waves in air give analogous results, but the current intensity decreases rapidly with increase of distance from the charge. The relation between current intensity and p.d. is approximately linear. The "ionization resistance" is an exponential function of the distance from the charge. The velocities of shock waves in air have been measured by increasing the electrical conductivity in two ways, viz. (1) by placing a reflector behind the probe and so increasing the pressure and temperature, and (2) by enveloping the probe in about 50 mg of lead nitride which detonates immediately on arrival of the shock front. The second technique is the more effective, and by its aid the arrival of shock waves have been determined in air for values of the pressure up to $p/p_0 = 20$. The measurement of velocities has been achieved by the use of a spiral brush whereby the spot is extinguished on passage of the shock wave past each probe.

J. S. G. THOMAS

534.23

5372. Measurement of ultrasonic attenuation in metals by the pulse method. S. Tanaka and T. Anzai. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **4**, 643–50 (*Dec.*, 1952).

A method for measuring ultrasonic attenuation in some common metals is described together with the results obtained in the frequency range from 500 kc/s to 6 Mc/s by the use of pulse techniques. Although the multiple-echo method has been widely applied in such measurement, many factors should be taken into consideration to obtain accurate results. In this research, to get rid as far as possible of errors due to these factors, many corrections were made in the use of the apparatus and the conditions of measurement. Attenuation constants were determined for four common metals, mild steel, cast iron, aluminium and copper. It seems that the resultant error is less than $\pm 10\%$ in every case. A.

534.23

5373. Measurements of sound absorption in aqueous salt solutions by a resonator method. O. B. Wilson, Jr and R. W. Leonard. *J. Acoust. Soc. Amer.*, **26**, 223–6 (*March*, 1954).

Presents the results of measurements of the sound absorption in aqueous solutions of several salts. While magnesium sulphate is the salt of primary interest in this case, some results for sea water at different temperatures, solutions of magnesium acetate, zinc sulphate and beryllium sulphate are given. The frequency range of the measurements is approximately 50 to 500 kc/s. Although the resonator method used is not very precise, it is the only known laboratory method which is able to give reliable absorption measurements in water and water solutions in this low-frequency range where the sound absorption in these liquids is extremely small. A.

534.23

5374. Absorption of ultrasonic radiation by soap solution. C. F. Brockelsby. Letter in *J. Acoust. Soc. Amer.*, **26**, 255 (*March*, 1954).

A very thin-walled copper tank containing water placed in the path of an ultrasonic beam causes

complete absorption when the water contains 1 part soap to 2000 water. The effect does not occur for 1 in 10 soap solution nor when distilled water is used. The effect is consequently thought to be due to insolubles precipitated by the soap, but to be inhibited by a coating of excess soap on the particles.

T. C. TOYE

534.23 : 539.13

5375. Studies on the transfer of vibrational energy in hydrocarbons. J. C. McCoubrey, J. B. Parke and A. R. Ubbelohde. *Proc. Roy. Soc. A*, **223**, 155–66 (*April* 22, 1954).

The dispersion of sound in pure ethylene has been reinvestigated at the frequencies 151 and 303 kc/s, at pressures ranging from 20 to 76 cm Hg and at temperatures from −3·4 to 25°C. On the basis that this dispersion is due to hindrances in the transfer translational ⇌ vibrational energy, the ethylene molecule has been used as a test system for comparing the efficiencies of pick-up of vibrational energy on collision with other molecules. Particular attention has been paid to paraffin hydrocarbons. From the observed dispersions in mixtures of ethylene with small proportions of other gases, the approximate number of collisions required for transfer of one quantum of vibrational energy from ethylene $(1 \rightarrow 0)$ is calculated. The high effectiveness in transmitting vibrational energy by the higher paraffin hydrocarbons investigated is discussed in terms of molecular flexibility and other aspects of the hydrocarbon structure. A.

534.231

5376. Sound field of a moving cylinder and a moving sphere. H. Zatzkis. *J. Acoust. Soc. Amer.*, **26**, 169–73 (*March*, 1954).

The simplest possible vibrators have been chosen, viz. a pulsating circular cylinder and a pulsating sphere. The solution is an infinite series in terms of Mathieu functions in the two-dimensional case, and in terms of prolate ellipsoidal functions in the three-dimensional case. Besides the rigorous solutions, asymptotic formulae valid for large distances away from the source are given. A.

534.231 : 535.32

5377. The study of a sound field by means of optical refraction effects. J. Kolb and A. P. Loeber. *J. Acoust. Soc. Amer.*, **26**, 249–52 (*March*, 1954).

An optical effect of an ultrasonic field discovered by R. Lucas and P. Biquard, namely the broadening of a slit image, can be computed in a simple way which is based on a method by Wiener. It is useful in the frequency range below 1 Mc/s for the point by point study of the pressure distribution in a stationary sound wave. Photographic records of this distribution were made. A simple method of measuring the wavelength is described. A.

534.232

5378. On the generation of high intensity ultrasonic energy and measurement of the output power density of a quartz crystal. T. C. Bhadra. *Indian J. Phys.*, **27**, 496–503 (*Oct.*, 1953).

An account of the measurement of the output power of a piezoelectric quartz crystal is given. The determination of the power output by a calorimetric substitution method is described. An output of 42·2 W/cm² for the quartz crystal, has been attain at a frequency of 1000 kc/s.

534.2

5379. A transducer to reduce standing wave C. L. Darner. Letter in *J. Acoust. Soc. Amer.*, **2** 255–6 (*March*, 1954).

An underwater sound transducer having a directivi pattern rotated 10 degrees from the normal to the fa of the transducer has been constructed and tested fo use in making measurements in a small tank. Stan ing waves between the faces of the two instrumen involved were thus eliminated or substantial reduced.

534.23

5380. Suppression of flexural vibrations of barium titanate. C. L. Darner. Letter in *J. Acoust. So Amer.*, **26**, 256–7 (*March*, 1954).

Thickness resonance excitation of barium titanat causes development of an intense shear mode which because of conservation of angular momentum produces transverse waves and a directivity patter with high fixed-angle side lobes. Suppression o flexural waves is discussed and illustrated. A

534.232

5381. Characteristics of radiating variable resonan frequency crystal systems. W. Welkowitz and W. J Fry. *J. Acoust. Soc. Amer.*, **26**, 159–65 (*March*, 1954)

Calculations based on the usual one-dimensiona theory of piezoelectric crystal systems have been carried out for several particular variable resonant-frequency crystal systems radiating into water. Curves are presented showing (1) power output as a function of frequency for operation both on and off resonance, (2) resonant frequency shift as a function of backing length and (3) relative band width as a function of frequency. The validity of certain approximations is checked so that the operating characteristics of systems made up of different materials can be quickly estimated. The curves indicate that a variable resonant-frequency system of crystals all of equal free-free resonant frequency operating with an allowable power variation for fixed applied field strength of 2 : 1 can have a continuous variation of resonant frequency of about 2·3 : 1. A system half the crystals of which have twice the free-free resonant frequency of the others for the same allowable field strength variation can operate over a frequency range of about 5·3 : 1. A.

534.232

5382. The lowest resonant frequency of a water-loaded circular plate. W. H. Peake and E. G. Thurston. *J. Acoust. Soc. Amer.*, **26**, 166–8 (*March*, 1954).

The resonant frequency for the lowest mode of a circular plate is calculated for the conditions of concentrated mass loading at the centre, water loading on one side, simply supported and clamped at the edge. These results are compared with those of Lamb and others. A.

534.232 : 621.395.61/.62

5383. The different representations of electro-acoustic transducers. F. A. Fischer. *Arch. elekt. Übertragung*, **7**, 569–74 (*Dec.*, 1953) *In German.*

There are two recognized forms of analysis for these transducers, into one of which (*a*) the non-

linearity of polarized transducers does not enter, while with the other (*b*) it does. As a result analysis (*a*) admits of two groups only of transducers, electrical and magnetic, while analysis (*b*) distinguishes as well between piezoelectric and dielectric and between electrodynamic and electromagnetic types. In addition, in case (*a*) the transducer is treated as a 2-pole network; in case (*b*) as a quadripole. The analyses are closely studied and a way in which one set of equations can be transferred to the other explained. As regards the quadripole formulae, the equation of motion of the dielectric transducer is shown to be the same as that of the piezoelectric except for the inclusion of an extra term which covers the energy stored in the capacitance and appears as an electrical "stiffness." The electromagnetic and electrodynamic equations are similarly related. H. G. M. SPRATT

534.24

5384. On nonspecular reflection at a rough surface. J. W. MILES. *J. Acoust. Soc. Amer.*, **26**, 191–9 (*March*, 1954).

The reflection of a plane wave at a rough interface separating two fluid media is examined in the approximation of "small roughness," such that second-order terms in the magnitude of the roughness may be neglected. Exact solutions are obtained when the roughness is harmonic, while asymptotic results are obtained for arbitrary distributions. The analysis deals principally with an incident wave that is harmonic in time, but the problem of the reflection of a pulse from a perfectly reflecting, sinusoidal boundary is solved. It is found that such a boundary acts as a band-pass filter of the nonspecular components of the reflected wave. Outside of this pass band the reflection is not only specular but distortionless. Rather less generality is possible when the boundary is not perfectly reflecting, but the pass band is found to be independent of the properties of the reflecting medium. A.

534.26

5385. The backscattering of sound from a harbor bottom. R. J. URICK. *J. Acoust. Soc. Amer.*, **26**, 231–5 (*March*, 1954).

When underwater sound strikes the bottom of the sea in shallow or deep water, a portion of its intensity is scattered back toward the source of sound. A study of the backscattering from the bottom as a function of pulse length, frequency and tilt-angle at several locations in a harbour along the East Coast, was made by using a tiltable transducer mounted on a barge. The results are expressed in terms of quantity called the "scattering strength" of a unit area of bottom. The results suggest that the backscattering of sound from a natural bottom is due more to its roughness rather than to the fact that it consists of sedimentary particles. Even at normal incidence the bottom of a sea or bay appears sufficiently rough for little sound to be returned by specular reflection. Some evidence in support of these conclusions is given. A.

534.321.9 : 61

5386. Ultrasound and medicine. A survey of experimental studies. J. F. HERRICK AND F. H. KRUSEN. *J. Acoust. Soc. Amer.*, **26**, 236–40 (*March*, 1954).

Ultrasound, although it may be dangerous in unskilled hands, is an excellent agent for the structural heating of living tissues. The term "structural heating" is used to denote heating at abrupt interfaces. The living organism presents numerous abrupt interfaces. Ultrasound promises to become a reliable diagnostic tool. Either the transmitted or the reflected ultrasonic energy can be used in this application. Tumours, gallstones, kidney stones, stones in the salivary glands, foreign bodies and abnormal collections of fluid have been located accurately. Preliminary observations on the use of ultrasound for certain biologic measurements are encouraging. Instrumentation for biologic measurement includes ultrasonic flowmeters, devices for measuring thickness of some tissue structures and equipment for measuring the viscosity of blood. A.

534.321.9 : 67

5387. The processing possibilities of ultrasonics. O. MATTIAT. *J. Acoust. Soc. Amer.*, **26**, 241–3 (*March*, 1954).

These are limited mainly by the economic factors of high first cost of equipment and high power cost per unit of processed material. In addition transducers suitable for large volume applications have only recently been developed. Processing possibilities which have led to industrial applications or which seem quite promising are reviewed. Among them are ultrasonic maturing of liquids, extraction, dispersing of dyes and pigments, emulsification, flotation ore dressing, degassing of water, oil and glass, soldering of aluminium, drilling and cleaning of metal parts. A.

534.321.9 : 672

5388. Uses of ultrasonics in degreasing processes. T. J. KEARNEY. *J. Acoust. Soc. Amer.*, **26**, 244–6 (*March*, 1954).

The Detrex Soniclean process combines sound energy and trichlorethylene solvent degreasing for metal cleaning. This is accomplished by immersing specially treated barium titanate transducers in chlorinated solvents producing cleaning results previously unobtainable. Crossrod, conveyorized equipment incorporating constant distillation and filtration of the solvent in the sonics chamber and providing a final vapour rinse and drying is now producing as many as 8000 parts per hour in industrial plants. A.

534.372 : 539.32

5389. On the dissipative viscoelastic constants of higher order. L. KNOPOFF. *J. Acoust. Soc. Amer.*, **26**, 183–6 (*March*, 1954).

The limitations imposed upon the usual elastic and viscoelastic constants are reinvestigated. Defining viscoelastic properties of a higher order, it is found that methods which have been used for the first-order quantities are insufficient to determine relationships between the higher-order constants. Necessary but nonsufficient criteria are arrived at by means of arguments involving energies in dissipative processes. A.

534.612

5390. On the theory of Rayleigh disc. N. KAWAI. *Sci. Rep. Tôhoku Univ. First Ser.*, **35**, 210–31 (*Jan.*, 1952).

The general formula of pressure and torque on a

Rayleigh disk is derived for arbitrary wavelengths and arbitrary incident angles of the acoustic wave. Numerical calculations are carried out to the point where the ratio of circumference of disk and wavelength of acoustic wave is increased to 4·0, that is, the wavelength is small compared with the size of disk. This is important because it is impossible to make the radius of disk smaller than a certain size for experimental reasons. Anomalous phenomena were found, the disk being moved by a torque which turns it parallel to the direction of propagation of the incident wave according to angles of incidence, when the ratio of circumference of disk and wavelength becomes greater than 2·5. As a rule, the oblate spheroidal co-ordinates are used for problems concerning the domain outside a circular disk, but the author used cylindrical co-ordinates for the same problems, taking special measures. Then only cylindrical functions appear in the expression, and the calculations are considerably simplified. The circular disk not only vibrates normal to its plane but also takes the rotational vibration around the suspension wire with same frequency as that of incident wave, and the lighter the disk compared with the fluid the more marked these vibrations become. The disk thickness must be taken into account when its radius is not large. The most general expressions accounting for the above two effects were obtained by neglecting the viscosity of the fluid and the Doppler effect, and previously obtained results were reduced to the special case here studied. A.

534.612

5391. Influence of "quartz wind" on measurements of ultrasonic output. G. SPENGLER. Note in *Naturwissenschaften*, **41**, *No.* 3, 59–60 (1953) *In German.*

A description is given of some experiments in a water tank of 90 litres capacity which showed that, with the usual method of finding the acoustic intensity from measurements of the radiation pressure, "quartz wind" effects gave rise to errors of 3 to 25% depending on the boundary conditions. H. J. H. STARKS

534.614

5392. The accuracy of the double-cell method for measuring the velocity of sound in liquids. N. S. TAŞKÖPRÜLÜ. *Rev. Fac. Sci. Univ. Istanbul A*, **18**, 143–52 (*April*, 1952).

The double-cell method firstly used by A. Sokollu, has been improved. A description of the arrangement, in which the principal part consists of two cells, between which a quartz crystal is clamped, is given. In the two cells standing waves are produced and observed by the diffraction of light. A method of finding from the diffraction patterns the ratio of the velocities of the sound, if the light-paths through the two cells are different, is described. The accuracy of the arrangement is then investigated experimentally. It is possible under the given conditions to find the velocity, with a relative error $\Delta v/v = 0{\cdot}5 \times 10^{-3}$, with two photographs. A.

534.62

5393. An anechoic tank for underwater sound measurements under high hydrostatic pressures. C. L. DARNER. *J. Acoust. Soc. Amer.*, **26**, 221–2 (*March*, 1954).

A tank for making acoustic measurements under hydrostatic pressures up to 1000 lb/in.^{2} and controlled temperatures from near freezing to near boiling is described. The internal treatment of the tank with wedges of Insulkrete, a sound absorbing material composed of pine sawdust and Portland cement, is described. Oscillograms of the pulsed signal show the reduction in reverberation level effected by Insulkrete. The conversion by Insulkrete of high frequency sound energy into heat is illustrated by schlieren photographs. A.

534.7 : 612.8

Physiological acoustics. Hearing. *See Abstr.* 6201–4

534.7

5394. Visual contribution to speech intelligibility in noise. W. H. SUMBY AND I. POLLACK. *J. Acoust. Soc. Amer.*, **26**, 212–15 (*March*, 1954).

Oral speech intelligibility tests were conducted with and without, supplementary visual observations of the speaker's facilial and lip movements. The difference between these two conditions was examined as a function of the speech-to-noise ratio and of the size of the vocabulary under test. The visual contribution to oral speech intelligibility (relative to its possible contribution) is, to a first approximation, independent of the speech-to-noise ratio under test. However, since there is a much greater opportunity for the visual contribution at low speech-to-noise ratios, its absolute contribution can be exploited most profitably under these conditions. A.

534.79 : 534.83

5395. Laboratory evaluation of field measurements of the loudness of truck exhaust noise. D. B. CALLAWAY AND H. H. HALL. *J. Acoust. Soc. Amer.*, **26**, 216–20 (*March*, 1954).

Simple loudness judgment tests were performed by a jury of 15 observers on the recorded noises of approximately 100 highway trucks. The loudness of the noises calculated by a modification of the equivalent tone method proposed by Beranek and co-workers ranges from about 20 to 200 sones. Observers were instructed to rank the noises in six loudness classes and were allowed to listen to a sample of class 1 and class 6 after each 20 recordings. The calculated loudnesses were then divided into six classes with class limits set by a 40% loudness increase per class. Although the subjective tests were conducted with no elaborate controls, a correlation coefficient of 0·94 was found between the average judgment of the group and the calculated loudness class. The correlation coefficient between average judgment and total sound pressure level was 0·78, whereas the correlation coefficient between the average judgment and the level on the *A*-network of the sound level meter was 0·83. Experimental techniques and the capabilities and limitations of the loudness-calculation methods are discussed. A.

534.833.4

5396. Perforated facing and sound absorption. U. INGARD. *J. Acoust. Soc. Amer.*, **26**, 151–4 (*March*, 1954).

In the analysis of the absorption characteristics of

a porous layer with perforated facing, it is usually assumed that the facing contributes only a mass reactance to the total impedance. It is shown that the facing also causes an additional acoustic resistance which is often larger than the acoustic resistance of the porous layer itself. This resistance is obtained only when the porous material is in close contact with the facing and becomes practically zero when the air space between facing and material exceeds approximately one perforation diameter. The effect is due to the near field (higher mode) losses in the porous material around the perforations. The resulting effect on the absorption characteristics is considerable, as demonstrated in some examples, and may at least partly explain reported disagreement between measurements and previous calculations. A.

534.844.4

5397. Reverberation times of some Australian concert halls. A. F. B. NICKSON AND R. W. MUNCEY. *Austral. J. appl. Sci.*, **4**, 186–8 (*June*, 1953).

Australia uses the City Halls of its major population centres for symphony and other concerts. Measurements of the reverberation times of these halls when full have been made for comparison with those of overseas concert halls. A.

534.861.1 : 534.84 : 621.396.712.3(43)

5398. The acoustics of the Cologne Funkhaus. L. MÜLLER. *Tech. Hausmitt. Nordwestdtsch. Rdfunks*, **5**, *No.* 5–6, 87–97 (1953) *In German.*

The reverberation time, its frequency characteristic and the diffusion properties determine the qualities of a studio. However, the purposes to which the studio will be put and the changing of musical taste demand facilities for varying the reverberation time. This variation must be inexpensive, without effect on the diffusion properties or the architectural design, and, of course, practicable. Of the few possible techniques, the use of plywood panels perforated with various sizes and numbers of holes and backed with damping material, e.g. glass wool, is the most satisfactory, the addition of profiling and of sloping ceilings being considered subsidiary. Several studios are described in detail with illustrations and their reverberation characteristics shown. These studios include those intended for light entertainment, chamber music, choral work, dance music and speech. One multipurpose studio is provided with movable slotted wall panels whereby the reverberation time can be varied from 0·6 to 1·2 sec. Another is very highly damped to simulate open-air conditions. In the case of one large studio embodying an auditorium great care has been taken, by means of damping, profiling and sloping of the roof, etc., to eliminate selective directions of reflection and particularly to protect the stage from first reflections from the audience. Sound insulation is briefly discussed. H. G. M. SPRATT

OPTICS . RADIATION . SPECTRA 535

535.214.4 : 537.29 : 538.61

5399. On the properties of intensely illuminated suspended particles in magnetic and electric fields. K. H. BALKENHOL. *Ann. Phys.* [*Leipzig*] **14**, *No.* 1–2, 17–32 (1954) *In German.*

Magneto- and electro-photophoresis, in which illuminated particles move along the lines of force, can be explained as a radiometer effect. When two particles coalesce they will do so with their magnetic or electric axes end to end and with the axis of the resultant particle along the lines of force. On illumination the two components, if of different size, will take up different temperatures and a radiometer force will act along the particle axis, i.e. along the lines of force. Experiments which support this theory are described. G. F. LOTHIAN

535.242

5400. A registering low-level photometer. W. E. K. MIDDLETON. *J. Opt. Soc. Amer.*, **44**, 303–5 (*April*, 1954).

A visual photometer has been devised which facilitates observations in the mesopic and scotopic ranges. By a special mechanical construction the observer is enabled to record about 60 readings without the necessity of removing his eye from the eyepiece of the instrument. Apart from its control box, the instrument is easily held in the hand. The field has an apparent diameter of 12 degrees, and is divided vertically. A.

535.245

5401. Researches on the Ulbricht sphere. H. KORTE AND M. SCHMIDT. *Lichttechnik*, **6**, 88–91 (*March*, 1954) *In German.*

Describes investigations carried out at the Physikalisch-Technische Bundesanstalt on three sources of error in the measurement of luminous flux by means of an integrating sphere. The screen disturbs the distribution of the reflected flux so that the illumination at any point of the sphere wall is not independent of the polar curve of the source. A translucent screen is suggested. The effect of differences of reflection factor over the sphere surface is investigated theoretically. Some paints are slightly selective as regards spectral reflection factor and this may affect the relative values obtained for sources of different colour temperatures. J. W. T. WALSH

535.247

5402. An instrument for the measurement of distinctness-of-image gloss. W. E. K. MIDDLETON AND A. G. MUNGALL. *Canad. J. Technol.*, **31**, 160–7 (*July–Aug.*, 1953).

The type of gloss known as distinctness-of-image gloss, which controls the sharpness of images in a reflecting surface, has hitherto resisted instrumental measurement. An instrument has been developed for this purpose, essentially an automatic goniophotometer which scans rapidly over a small range of angles centred on the angle of specular reflection, and by electronic means measures the maximum slope of the goniophotometric curve. The meter readings given by this instrument correlate well with the judgments of observers who use no optical aids. The principle of the instrument is the subject of a patent application. A.

535.247.1

5403. Universal high-sensitivity photometer. G. OSTER. *Analyt. Chem.*, **25**, 1165–9 (*Aug.*, 1953).

A high-sensitivity photometer with readily inter-

changeable optical components was needed in order to carry out a wide variety of accurate photometric measurements on a single instrument. A photometer has been developed employing a photomultiplier tube whose output is amplified by means of an electrometer tube. The instrument is capable of measuring light intensities down to 20 microlamberts. Coloured filters, neutral filters and polarizer may be inserted in various combinations for both the incident and observed beams. The receiver phototube may be rotated about any angle with respect to the incident beam. Cells for liquid samples (including micro quantities) and flat samples have been constructed. The performance of the instrument is illustrated by twelve distinct types of measurements, which include quantitative measurements of light scattering (turbidity, particle counting and dissymmetry), luminescence (fluorescence, phosphorescence and chemiluminescence), transmittance of high absorbance systems and reflectance goniometry. A.

535.247.4

5404. A portable photometer for the testing of reflective road signs. R. G. GIOVANELLI. *J. sci. Instrum.*, **31**, 126–9 (*April*, 1954).

A description is given of a portable colour-corrected photoelectric photometer suitable for the testing of reflective surfaces as used on road signs, and of individual retro-reflectors. The reflection factors obtained with it agree reasonably well with those obtained at 0·5° divergence by other methods. A.

535.247.4 : 537.363

5405. A fully automatic recording densitometer for scanning paper electrophoresis patterns. D. J. R. LAURENCE. *J. sci. Instrum.*, **31**, 137–8 (*April*, 1954).

A densitometer is described depending on the use of a photomultiplier operated at constant anode current. The application of this instrument to evaluation of electrophoresis data from filter paper strips is discussed. Some advantages of the circuit are outlined. A.

535.316

5406. The layout of optical systems. F. I. HAVLIČEK. *Bull. sci. Cons. Acad. Yougoslavie*, **1**, 69–70 (*Nov.*, 1953) *In German.*

Equations for the transverse chromatic aberration of a system of thin lenses are derived. These are of use in the preliminary design stage of a lens system and their application to a separated triplet is briefly demonstrated. R. W. FISH

535.316

5407. Matrix algebra for ideal lens problems. J. H. HARROLD. Letter in *J. Opt. Soc. Amer.*, **44**, 254 (*March*, 1954).

An alternative method to that of Satten [Abstr. 1484 (1953)] using matrix algebra to link the object and image spaces of a thin lens system is suggested. This method gives no loss of information as compared with the use of the ideal lens equations, although its practical value is debatable. R. W. FISH

535.317

5408. Solutions of two optical problems. A. FLETCHER, T. MURPHY AND A. YOUNG. *Proc. Roy. Soc. A*, **223**, 216–25 (*April* 22, 1954).

The first problem is to find the spherically symmetrical distribution of refractive index inside a sphere (the refractive index outside being uniform) that brings rays starting from a given external point *A*, and falling on the sphere, to an exact focus at a given external point *B*, where *AB* necessarily passes through the centre *O* of the sphere. The solution given by Luneberg (1944) is here derived from an integral equation of Abel's type, in a way slightly different from Luneberg's, and is then developed so as to provide numerical results. Coefficients of general utility in the problem are given in a table. The remaining tables relate to particular cases, and especially to the three cases in which, *A* being at infinity so that the incident beam consists of parallel rays, *OB* equals 2·3, 2·5 and 2·7 times the radius of the sphere. In these three cases the refractive index at the centre of the sphere is respectively 1·150, 1·13 and 1·126 times that outside the sphere, and the variation of refractive index from centre to surface is tabulated in final form. The second problem is to find the axially symmetrical distribution of refractive index in a cylindrical lens terminated by a plane face perpendicular to the axis that brings a parallel beam travelling parallel to the axis and incident normally on the plane face exactly to a focus at a point on the axis of the lens. It is found, again from an integral equation of Abel's type, that the refractive index must be proportional to sech $(\pi r/2F)$, where r denotes distance from the axis and F denotes the distance of the focus from the plane face. A

535.317.

5409. Third order aberrations of a mirror lens. J. BARTKOWSKA. *Acta phys. Polon.*, **12**, *No.* 1, 57–6 (1953).

Formulae for the aberrations are proved. As compared with analogous formulae for simple refracting lenses, these formulae show explicitly the advantages of using such lenses for the design of optical instruments. A

535.317.

5410. Conrady's chromatic condition. D. P. FEDER *J. Res. Nat. Bur. Stand.*, **52**, 43–9 (*Jan.*, 1954).

In 1904 Conrady published a simple and ingenious formula for determining the state of chromatic correction of an optical system. This method, called the "*D-d* achromatism," depends upon the variation of the optical path as a function of wavelength. It can be used to evaluate both axial and lateral colour, chromatic variation of spherical aberration and secondary chromatic aberration. Unfortunately, this method is not as well known or as widely used as it deserves to be. This paper proves the exact equation and discusses an extension of it which is approximate. A numerical example illustrates the accuracy obtainable with the approximation. The principal applications are presented and formulae derived giving the relations between the "*D-d* method" and conventional means of expressing the chromatic aberration. A.

535.322.4

5411. Precision refractometer with simple measuring prism. A. C. S. VAN HEEL. *Appl. sci. Res. B*, **3**, *No.* 2, 119–24 (1953).

The construction of the refractometer described in Abstr. 3970 (1953) has been simplified. The measuring

prism consists of one piece of glass on the top surface of which the solid or liquid sample is put and of which one of the lateral surfaces receives light from the same light source as the sample by means of an auxiliary reflector. The opposite side of the prism is not limited by one plane surface, but by two planes inclined to each another, thus splitting up the pencil into two. These pencils are then split into four pencils each by means of a fourfold mirror as in the original apparatus; the pencil given by the sample also is split into four pencils by the same mirror. The range of temperatures at which observations can be made is greatly enlarged. The precision is again about 0·00001, the range 1·31 to 1·67. A.

353.323

5412. Refractive index of cesium bromide for ultraviolet, visible, and infrared wavelengths. W. S. RODNEY AND R. J. SPINDLER. *J. Res. Nat. Bur. Stand.*, **51**, 123–6 (*Sept.*, 1953).

This was measured at 37 wavelengths from 0·365 to 39·22 μ. The minimum deviation method was used, and the entire range was covered with a single instrument. The index changes approximately two units in the first decimal place over the wavelength range. The dispersion compares favourably with that of KRS–5 beyond 20 μ; and when the effects of inhomogeneity and reflection losses are considered, the resolving power of CsBr is probably better. A.

535.323–15 : 535.345–15

5413. The infra-red properties of bismuth. J. N. HODGSON. Letter in *Proc. Phys. Soc.* [*London*] *B*, **67**, 269–70 (*March*, 1954).

A reflection method was used to measure the optical constants for a polished mirror of Bi, at wavelengths between 1 and 10 μ. An absorption minimum corresponding to an energy gap of 0·3 eV was found, and calculations from the optical constants give a value of 5·1 for the number of free electrons per atom in Bi. D. G. AVERY

535.325

5414. A new determination of the refractive index of gaseous fluorine. E. U. FRANCK. Note in *Naturwissenschaften*, **41**, *No.* 2, 37 (1954) *In German.*

The refractive index was measured with the use of an interferometer and with A as comparison. From the results the index was calculated for standard pressure and temperature by means of the ideal gas law, as the discrepancies from this are less than 0·1% for F_2. The dispersion is also very small, so that no correction was necessary. The refractive index, molecular refraction and dielectric constant are tabulated, $n - 1$ being 214×10^{-6}. A. J. TAYLOR

535.327

5415. Temperature variation of the refractive index of fused quartz. P. S. NARAYANAN. *J. Indian Inst. Sci. A*, **35**, 9–15 (*Jan.*, 1953).

Using an interference method the temperature variation of the refractive index of fused quartz of optical quality was studied from 30°C to 750°C. The existence of an irregularity close to the α–β transformation temperature of quartz was confirmed and a secondary maximum close to the transformation temperature of cristobalite is pointed out. A.

535.33.03

5416. On the continuum [emitted] from impulse discharges through capillaries. K. WELTNER. *Z. Phys.*, **136**, *No.* 5, 631–41 (1954) *In German.*

An experimental paper dealing with the visible and near-u.v. radiations from high-current-density condensed discharges through capillary tubes. The effect of varying the wall material is studied and spectra are shown for glass and alumina capillaries. Current densities may reach 130 000 A/cm^2. Pressures were generally between $\sim 0 \cdot 1$ and ~ 1 mm Hg.

J. D. CRAGGS

535.33.03

5417. The decomposition of CF_4 in flames. D. E. MANN, H. P. BROIDA AND B. E. SQUIRES. Letter in *J. chem. Phys.*, **22**, 348–9 (*Feb.*, 1954).

Spectra of C_2H_2/O_2 flames with added CF_4 give the $A^2\Sigma \rightarrow X^2\Pi$ system of CF, including new (0, 2) and (0, 3) bands. The *B* system of CF and bands of CF_2 were not observed. Spectra of impurities were troublesome; CS and CCl occur in $C_2H_2/O_2 + CF_4$; CuO, CuCl and CuF in $H_2/O_2 + CF_4$. A. G. GAYDON

535.33.03 : 535.332–31

5418. Continuous emission spectrum of Xe in the vacuum ultraviolet region. Y. TANAKA AND M. ZELIKOFF. Letter in *J. Opt. Soc. Amer.*, **44**, 254–5 (*March*, 1954).

Describes a continuous emission from about 1400 to 1900 Å, obtained with microwave excitation (2450 Mc/s) of pure Xe at pressures $\sim$1–10 mm Hg. A brief discussion is given. J. D. CRAGGS

535.33.03 : 537.525.5

5419. High voltage arcs in argon-nitrogen mixtures. R. W. NICHOLLS. Letter in *Nature* [*London*] **173**, 495–6 (*March* 13, 1954).

Describes excitation mechanisms, mainly involving vibrational levels of the $X^1\Sigma_g^+$ state of N_2, relevant to arcs struck at $\sim$600 mm Hg in A–N_2 mixtures (99·5%–0·5%). J. D. CRAGGS

535.33.03–15

5420. Improved wavelengths for some infrared lines in the arc spectrum of carbon. L. MINNHAGEN. *Ark. Fys.*, **7**, *Paper* 33, 413–14 (1954).

Lists certain lines, for wavelengths about 8000–10 000 Å, observed with an electrodeless discharge containing argon with a small amount of neon (pressures $\sim$ a few hundreds mm). J. D. CRAGGS

535.33.07

5421. A new small quartz spectrograph. E. LAUTENSCHLAGER. Note in *Naturwissenschaften*, **41**, *No.* 2, 34–5 (1954) *In German.*

A description of a rugged, portable instrument of conventional optical design, having a fixed slit and a built-in miniature film camera. An optical device is provided to allow correct alignment on the source.

S. T. HENDERSON

535.33.07

5422. Stray light in a spectrophotometer caused by internal reflection in a 60° prism. H. D. EINHORN AND A. E. Z. COHEN. *J. Opt. Soc. Amer.*, **44**, 232–3 (*March*, 1954).

The light appears as a "ghost" line at the spectrum

position of minimum deviation, of an intensity corresponding to about 0·1% of the energy of the total spectrum. Means of eliminating or utilizing it are discussed. A.

535.33.07

5423. Absorption spectrum sorter. T. ELDER AND W. BENESCH. *J. Opt. Soc. Amer.*, **44**, 279–83 (*April*, 1954).

A method has been designed for use in absorption spectroscopy in which the simultaneous recording of the spectra of two diverse substances produces spectrum lines which extend in either the positive or negative sense from a "base" line, depending on the originating substance. Thus the spectrum is automatically sorted, and the identification of lines is unambiguous. The paper describes the principles of operation of the Spectrum Sorter and its construction through the modification of a double beam infrared spectrometer. Also discussed are the application of the Spectrum Sorter principle to the handling of comparison spectra, to the identification of absorbing substances and to the enhancement of resolution. A.

535.33.07 : 535.243

5424. On a graphic method of eliminating the background in photographic spectrophotometry. M. D. KUNISZ. *Acta phys. Polon.*, **12**, *No.* 1, 3–7 (1953).

Dorgelo's spectrophotometric method cannot be employed directly if the spectral lines appear on a background of a continuous spectrum which cannot be eliminated by laboratory means. A graphic method of eliminating the background is suggested and employed to determine the ratio of intensities of spectral lines of the composed triplet $4d^3D - 4p^3P^0$ *Zn* I. A

535.33.07 : 535.243

5425. An integrating spectrometer for measuring spectral intensities by the counting of photo-electrons. J. A. SMIT, J. M. W. MILATZ AND C. SMIT. Letter in *Physica*, **20**, 39–40 (*Jan.*, 1954).

Radiations from 2 spectrum lines are incident alternately at 100 c/s on a photomultiplier whose output finally goes to two counters. G. F. LOTHIAN

535.33.07 : 535.339

5426. Water-prism ultraviolet monochromators. D. J. FLUKE AND R. B. SETLOW. *J. Opt. Soc. Amer.*, **44**, 327–30 (*April*, 1954).

Two large water-prism monochromators are described. One uses a free water surface and the other is a triangular prism enclosed by quartz plates. The monochromators are used to irradiate biological systems and their components with monochromatic light of wavelength >2000 Å. Details of construction and performance are given. A.

535.33.07 : 537.531

A Geiger-counter vacuum spectrometer. *See Abstr.* 5657

535.331

5427. Description and analysis of the first spectrum of chromium, Cr I. C. C. KIESS. *J. Res. Nat. Bur. Stand.*, **51**, 247–305 (*Nov.*, 1953).

Wavelengths and estimated intensities are presented for about 4400 lines of Cr I recorded photographically between 11 610 Å in the infrared and 1880 Å in the ultraviolet. Zeeman patterns, measured in magnetic fields of 35 000 and 85 000 oersteds for approximate 10% of the lines, are presented also. Analysis of t spectrum with these observational data has yield classifications for about 80% of the Cr I lines, combinations among the terms that arise from t various configurations assumed by the valan electrons of the atom in its excited and unexcit states. Of these terms 53 have been found due to t even electron configurations $3d^5\,ns$, $3d^4\,ns^2$, $3d^6$ a $3d^5\,nd$; and 115 due to the odd configurations $3d^5\,n$ and $3d^4\,4s\,np$. Among both even and odd ter several series of two or more members have be found converging to the ground state $a\,^6S$ and to t metastable state a^6D of Cr II. The ^7S, ^5S and ^{7} series, of three or more members, that converge to a " are in remarkable accord in fixing the separation the ground states of the neutral and singly ionized C atoms as 54 570 cm^{-1}. This corresponds to a ionization potential of 6·764 eV. A

535.33

5428. Term values in the spectrum of chromium I V. SURYANARAYANA AND V. RAMAKRISHNA RA *Indian J. Phys.*, **27**, 585–90 (*Dec.*, 1953).

Term values for the configurations $3d^5$, $3d^4.4$ $3d^3.4s^2$ in Cr II are calculated and compared with th experimental data due to Kiess [Abstr. 7155 (1952)] The values of the unidentified terms are predicte from these theoretical calculations. A

535.33

5429. Emission characteristics of vacuum spark dis charges. II. Aluminium spectra in the extrem ultraviolet. R. W. KEBLER, W. W. MCCORMICK AN R. A. SAWYER. *J. Opt. Soc. Amer.*, **44**, 270–5 (*Apri* 1954).

For Pt I, see Abstr. 3096 (1953). A study o spectra of several-times-ionized atoms in a vacuum spark has been extended into the far ultraviolet Thirty-two lines from the fourth, fifth, sixth an seventh spectra of aluminium have been photographed either in first or second order in the region from 230 to 330 Å. The spark was operated at voltages between 5 and 20 kV with the aid of a gas trigger, and by varying the self-inductance between about 2 and 40 μh, peak currents ranging from 15 to 62 kA were obtained. Eastman SWR plates, calibrated by a time-varied method, were used for quantitative measurement of exposure values of the spectral lines. The data indicate that the relative excitation of the spectra of different stages of ionization is nearly a linear function of the current. However, a marked enhancement at 10 kV, 30 kA and minimum induc tance shows that the excitation process must depend also on other parameters. An apparent splitting of some of the Al IV lines at the higher currents has been attributed to self-reversal. A.

535.338

5430. Spectroscopy of the solid state: some of the transition elements. E. M. GYORGY AND G. G. HARVEY. *Phys. Rev.*, **93**, 365–9 (*Feb.* 1, 1954).

The $3P_{\frac{3}{2},\frac{1}{2}}$ emission curves of nickel, manganese and iron have been obtained by using a vacuum recording spectrograph. A plausible interpretation of a number of features of the experimental bands is discussed. A.

535.338.3

31. The emission spectrum of americium. I. R. P. HORNE. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. R* 1309, 3 *pp.* (1953).

Some two hundred and thirty lines of the emission spectrum of americium have been recorded. The ranges covered were from 2000 to 10 000 Å using a high wattage spark unit and from 2500 to 5000 Å by arcing at 3 amps d.c.. A.

535.338.3 : 538.615

432. On a non-regular splitting pattern in the inverse Zeeman effect for the potassium resonance lines. J. TOMISER. Note in *Naturwissenschaften*, **41**, *No.* 2, 34 (1954) *In German.*

Photographs and microphotometer curves are given for the Zeeman patterns for K taken at a saturation pressure of 0·1 mm Hg. Both π and α components were strongly unsymmetrical about the original line position, where a forbidden component was also observed. Other forbidden lines occurred at 7/3 and 5/3 Lorentz units on the shorter wavelength side.

S. T. HENDERSON

535.338.332

5433. The de-excitation of helium metastable atoms in helium. E. H. S. BURHOP. Note in *Proc. Phys. Soc. London*] *A*, **67**, 276–80 (*March*, 1954).

Experimental evidence on the destruction of metastable helium atoms $He^*(He(2^3S)$ or $He(2^1S))$ are consistent with the interpretation that two processes are important: (1) $He^* + He^* \rightarrow He^+ + He + e$ and (2) $He^* + He + He \rightarrow He + He + He + h\nu$ by way of several intermediate processes.

G. E. BROWN

535.338.332

5434. Hyperfine structure in the spectra of Sb, Sm, Hg, and Cd. K. MURAKAWA. *Phys. Rev.*, **93**, 1232–5 (*March* 15, 1954).

Using two samples that were enriched in Sb^{121} and Sb^{123}, respectively, the hyperfine structure (h.f.s.) of the spectrum of Sb II was studied, and the quadrupole moments were determined to be $Q(Sb^{121}) = (-0{\cdot}52 \pm 0{\cdot}10)\times10^{-24}$ cm^2, $Q(Sb^{123}) = (-0{\cdot}67 \pm 0{\cdot}10)\times10^{-24}$ cm^2. Study of the h.f.s. of the spectra of Sm I and Sm II, using two samples enriched in Sm^{147} and Sm^{149}, respectively, yielded the result that the nuclear spins of Sm^{147} and Sm^{149} are 7/2 and their nuclear magnetic moments are $\mu(Sm^{147}) = -0{\cdot}76 \pm 0{\cdot}08$ n.m. and $\mu(Sm^{149}) = -0{\cdot}64 \pm 0{\cdot}06$ n.m. with $\mu(Sm^{147})/\mu(Sm^{149}) = 1{\cdot}198 \pm 0{\cdot}015$. Using a sample containing 1·5% of Hg^{196}, the h.f.s. of the line Hg II λ6150 was studied, and the existence of the Hg^{196} component was just observed. Shifts of the even isotopes in the lines Hg I λ5461, Hg I λ6123 and Hg III λ4797 were measured, and it was found that they follow the regularity mentioned earlier. Using natural cadmium, the h.f.s. of the line Cd II λ4415 was studied, and the shift Cd^{114}–Cd^{116} was found to be anomalously small compared with the shift Cd^{112}–Cd^{114}. A.

535.338.334

5435. Line width of rotational spectra of some symmetric top molecules due to nuclear quadrupole moments. T. ITO, Y. TANABE AND M. MIZUSHIMA. *Phys. Rev.*, **93**, 1242–8 (*March* 15, 1954).

The hyperfine structure of rotational spectra is sometimes so complicated that it cannot be analysed easily. In many other cases it is difficult to resolve the h.f.s. and the whole spectrum is observed as a somewhat broad single line. In these cases the line width or the mean-square frequency deviation may have a more practical significance. In this paper explicit formulae are given for the mean-square frequency deviation as a function of the nuclear quadrupole coupling constant and the quantum numbers I, J, K. Thus by means of these formulae the nuclear quadrupole coupling constant may be obtained from the line width of the rotational line without analysing h.f.s. Calculations were made on symmetric top molecules which have one or three identical nuclei with electric quadrupole moments. The effect of other nuclei which have electric quadrupole moments can be easily taken into account. The method of separating the present line width from that of the pressure broadening and that due to the centrifugal distortion is discussed. A.

535.338.334 : 537.228.5

5436. Broadening of spectral lines resulting from the quadrupole Stark effect. I. I. SOBEL'MAN AND L. A. VAĬNSHTEĬN. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 5, 757–60 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-161.

The quadrupole Stark effect arising from the electric field of a point charge is calculated for atoms with one valence electron and for atoms with several non-equivalent valence electrons. Collision damping by the quadratic dipole effect is employed to explain the broadening of various solar spectral lines, and estimates of contributions to this broadening by the quadrupole Stark effect are given. Further, the role of the quadrupole effect in the broadening of lines of ions colliding with hydrogen is considered. In this case the ion polarizes the hydrogen, producing a quadrupole electric field. G. E. BROWN

535.338.4

5437. The $^5\Pi$–$^7\Sigma$ electronic transition in MnBr and MnF. P. TIRUVENGANNA RAO. *Proc. Nat. Inst. Sci. India*, **19**, 149–51 (*March–April*, 1953).

The emission spectra of MnBr and MnF were excited in a heavy current discharge through the vapour and photographed in the visible region using a Fuess glass spectrograph. The γ system in each of these molecules has been interpreted on the basis of a $^5\Pi$–$^7\Sigma$ transition, as in the case of a similar system in MnCl. A.

535.338.4

5438. Intensity formulae for bands involving high multiplicity terms. I. $^5\Sigma$–$^5\Sigma$ and $^6\Sigma$–$^6\Sigma$ transitions. D. PREMASWARUP. *Indian J. Phys.*, **27**, 415–20 (*Aug.*, 1953).

The intensity expressions for the rotational lines in $^5\Sigma$–$^5\Sigma$ and $^6\Sigma$–$^6\Sigma$ transitions are derived. Representative theoretical curves are drawn for the branches showing the variation of the intensity with J. A.

535.338.4

5439. Intensity formulae for bands involving high multiplicity terms. II. $^5\Pi$–$^5\Sigma$, $^5\Pi$–$^5\Pi$, and $^4\Pi$–$^4\Pi$ transitions. D. PREMASWARUP. *Indian J. Phys.*, **27**, 578–84 (*Nov.*, 1953).

Transitions and intensity formulae are derived for the rotational lines of bands due to the transitions

$^5\Pi(a)$–$^5\Sigma$, $^5\Pi(b)$–$^5\Sigma$; $^5\Pi(a)$–$^5\Pi(a)$, $^5\Pi(a)$–$^5\Pi(b)$ and $^5\Pi(b)$–$^5\Pi(b)$; and $^4\Pi(a)$–$^4\Pi(a)$, $^4\Pi(a)$–$^4\Pi(b)$ and $^4\Pi(b)$–$^4\Pi(b)$. A.

535.338.4

5440. The laboratory determination of relative transition probabilities of diatomic molecules. I. The α-system of TiO J. G. Phillips. *Astrophys. J.*, **119**, 274–85 (*Jan.*, 1954).

An electric furnace and a photoelectric spectrum-scanning technique were used to produce the intensity distribution-curve in the spectrum of the α-system of TiO from 4500 to 6200 Å. The relative intensities of individual bands of the system were determined by matching their observed profiles with profiles determined theoretically. The resulting relative transition probabilities are tabulated. A.

535.338.4–13

5441. The complex band spectrum of the diatomic molecule CbO in the photographic infrared. V. Ramakrishna Rao and D. Premaswarup. *Indian J. Phys.*, **27**, 399–405 (*Aug.*, 1953).

Using Kodak 1-N plates a band system due to the NbO, (CbO), molecule was obtained in the infrared for the first time. Bands in the region λ7679–6033 are reported with an analysis. Possible interpretations of the electronic transition are discussed. A.

535.338.42

5442. Vibrational transition probabilities of diatomic molecules; collected results. II. N_2^+, CN, C_2, O_2, TiO. P. A. Fraser, W. R. Jarmain and R. W. Nicholls. *Astrophys. J.*, **119**, 286–90 (*Jan.*, 1954).

For previous part, see Abstr. 2273 (1954). Arrays of approximate vibrational transition probabilities, i.e. $p(v', v'')$ = (overlap integral)^2, are presented for the following molecular transitions of astrophysical interest: N_2^+: $A\,^2\Pi_u \rightarrow X\,^2\Sigma_g^+$ (Meinel) CN: $A\,^2\Pi \rightarrow X\,^2\Sigma^+$ (red) $B\,^2\Sigma^+ \rightarrow X\,^2\Sigma^+$ (violet) C^2: $A\,^3\Pi_g \rightarrow X\,^3\Pi_u$ (Swan) O_2: $b^1\Sigma_g^+ \rightarrow X\,^3\Sigma_g^-$ (atmospheric) $B\,^3\Sigma_u^- \rightarrow X\,^3\Sigma_g^-$ (Schumann–Runge) TiO: $A\,^3\Delta \rightarrow X\,^3\Pi$ (γ). The methods employed in the computation of these values are indicated. A.

535.343

5443. The absorption spectrum of lutetium. L. F. H. Bovey and W. R. S. Garton. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 291–3 (*March*, 1954).

Measurements at temperatures up to 2400°C over the region 2600–6050 Å. A table of the lines found and of their comparative strength is given.

C. TURNER

535.343 : 539.132

Dissociation energies and spectra of diatomic molecules. *See Abstr.* 5838

535.343–15

5444. Remarks on the infrared spectra of metallic salts containing groups of the XO_2-type ion. C. Duval and J. LeComte. *J. Opt. Soc. Amer.*, **44**, 261–3 (*April*, 1954).

It is shown that metaborate (and orthoborate) polymerize. Vibration spectra of the metallic metaborates indicate that the BO_2^- does not exist in the free state but under the polymerized form $(BO_2)_n$. Postulations are made concerning this structure. A.

535.343

5445. Infrared spectrum of σ_2 for $B^{10}F_3$ and B^{11} A. H. Nielsen. *J. chem. Phys.*, **22**, 659–64 (*A*[illegible] 1954).

The infrared grating spectra of σ_2 for $B^{10}F_3$ [illegible] $B^{11}F_3$ have been re-examined from 650 to 750 Two samples of BF_3, one composed of 93·4% B^{1} and 6·6% of $B^{11}F_3$ and the other of the nor abundance ratio 20% $B^{10}F^3$ and 80% $B^{11}F_3$ w secured for the investigation. Complete resolution the rotational fine structure of this parallel-type b was achieved. The following constants were obtai by means of the usual rotational analysis: for B^{10} $\sigma_0 = 718{\cdot}23$ K, $B_0 = 0{\cdot}3527_2$ K, $B(v_2 = 1)$ $0{\cdot}3528_8$ K, $D_J = 13{\cdot}72 \times 10^{-7}$ K. For $B^{11}F_3$, σ_0 691·45 K and the rotational constants are the sa for the isotopic species.

535.343–15 : 539.1

5446. Vibrational spectra of tetrafluoroethylene a tetrachloroethylene. D. E. Mann, N. Acquista A. E. K. Plyler. *J. Res. Nat. Bur. Stand.*, **52**, 67– (*Feb.*, 1954).

The infrared spectra of gaseous tetrafluoroethyle from 22 to 52 μ and liquid tetrachloroethylene fr 3 to 52 μ have been determined. Several hithe unobserved bands were found. New and satisfacto assignments, for which a detailed discussion is give have been achieved. The out-of-plane force constan are discussed and used to predict the wagging a torsion frequencies of tetrabromoethylene. Tables the thermodynamic functions for tetrafluoro- a tetrachloroethylene are presented.

535.343–

5447. The ultraviolet absorption spectra of phenet and *n*-butylbenzoate in different states. A. R. D *Indian J. Phys.*, **27**, 457–64 (*Sept.*, 1953).

The absorption spectra of phenetole in the liqui and solid states and those of *n*-butylbenzoate in t vapour, liquid and solid phases were photographed the region between 2820 and 2500 Å, using thin film of the substances in the case of the liquid and sol phases. In the absorption spectrum of phenetole the liquid state at 30°C, three broad bands are observe with the ν_0-band at 35 771 cm^{-1} and other ban corresponding to a progression of vibration frequency 901 cm^{-1}. In the solid state at −180°C th broad bands observed for the liquid state becom much sharper and each is accompanied by three fai bands. The bands correspond to the vibration frequencies 560, 773, 902, 945 and 1272 cm^{-1} an their combinations. The ν_0-band in the solid stat at −180°C is shifted towards longer wavelengths b 38 cm^{-1} from its position in the liquid state and b 629 cm^{-1} from its position in the vapour state. Th absorption spectrum of *n*-butylbenzoate in the vapou state yields 9 bands with the ν_0-band at 36 099 cm^{-1} and progression of vibrational frequencies 360 an 944 cm^{-1} and their combinations. In the liquid stat at 32°C the substance yields only three bands corre sponding to vibrational frequency 952 cm^{-1} and th whole spectrum is shifted by about 573 cm^{-1} toward longer wavelengths. When the liquid is solidified an cooled to − 180°C the bands shift by about 100 cm^{-1} towards longer wavelengths and become a littl sharper. These results are discussed in detail. A

535.343–31

448. On the ultraviolet absorption spectra of luidines in the liquid and solid states. U. R. G. SWAS. *Indian J. Phys.*, **27**, 603–9 (*Dec.*, 1953).

The ultraviolet absorption spectra of ortho, meta, nd para toluidine were photographed. The results r the para compound in the vapour state agree with ose reported by Tintea (1933). It is observed that hen the substances are liquefied the narrow bands e replaced by an extended broad band. This broad and persists even when the liquids are solidified and ooled down to −180°C. The region of this extended bsorption shifts towards longer wavelengths in each ase with liquefaction of the vapour and it does not ift appreciably with the solidification of the liquids nd lowering of temperature of the solid to −180°C. hese results are compared with those for chloro- oluenes and dichlorobenzenes reported by Swamy Abstr. 2296–7 (1954)], and it is pointed out that the ehaviour of the bands with solidification of toluidines s opposite to that observed in the case of chloro- oluenes and dichlorobenzenes. A.

535.343–31

449. Absorption intensities of the isomeric pentenes n the vacuum ultraviolet. D. SEMENOW, A. J. HARRI- ON AND E. P. CARR. *J. chem. Phys.*, **22**, 638–42 *April*, 1954).

Quantitative measurements of the absorption spectra of the six isomeric pentenes in vapour phase have been made in the region 45 000–65 000 cm^{-1}. The maximum of the intense band ($N \rightarrow V$) is the same for 1-pentene, *cis*-2-pentene, and 2-methyl-2-butene, with one, two, and three alkyl substituents, respectively. The results show that in a series of hydrocarbons, where the molecular weight is unchanged and the number of alkyl groups is the only variable, the position of the $N \rightarrow V$ maximum is not a function of the number of alkyl substituents. From the standpoint of methyl substituents, there is no shift between *cis*-2-pentene with one methyl group and 2-methyl-2-butene with three. In the absence of such a shift, spectral evidence in support of hyperconjugation in the substituted ethylenes is lacking. The $N \rightarrow V$ maximum for *trans*-2-pentene is less intense and at somewhat longer wavelength than for the *cis*-isomer. The greatest shift in this band is with 2-methyl-1-butene, where the two alkyl groups are on the same carbon atom. These results indicate the importance of molecular shape in determining the energy of the $N \rightarrow V$ transition in the mono-olefins. The positions of the shallow bands ($N \rightarrow R$) on the long wave side of the $N \rightarrow V$ band are in substantial agreement with earlier measurements and confirm the conclusion that the energy of this transition is dependent on the number of alkyl substituents on the carbon atoms of the double bond. The possibility of other Rydberg bands on the short wave side is discussed briefly. Oscillator strengths for the $N \rightarrow V$ band are given for the six pentenes; these vary from 0·26 in 2-methyl-1-butene to 0·45 in *cis*-2-pentene but their value for testing theoretical predictions is doubtful because of the overlapping of different electronic transitions. A.

535.343.2

5450. The absorption spectrum of chlorophyll α crystals. E. E. JACOBS AND A. S. HOLT. Letter in *J. chem. Phys.*, **22**, 142 (*Jan.*, 1954).

A diagram is given of the absorption spectrum of chlorophyll α microcrystals suspended in petroleum ether from 400 to 800 mμ. The phytyl side-chain does not seem to affect the interactions between the conjugated ring-systems. This is in agreement with the observation, taken from absorption spectra of monomolecular layers, that chromophore interactions are mostly confined to a single plane. A. J. TAYLOR

535.343.2

5451. The absorption spectra of monomolecular layers of chlorophyll α and ethyl chlorophyllide α. E. E. JACOBS, A. S. HOLT AND E. RABINOWITCH. Letter in *J. chem. Phys.*, **22**, 142–3 (*Jan.*, 1954).

A new method is described of preparing these layers. Diagrams are given of the absorption spectra between 400 and 800 mμ. Results show the same shifts towards longer wavelengths as are observed in the solids, so that resonance interactions in the crystals are probably confined to the layer planes. Values are given of the absorption coefficients and surface requirements of the molecules. Presence of Ca^{++} in the water used may cause the formation of bi-molecular layers, out of which three-dimensional crystals seem to be built. Chloroplasts and grana may contain loose but not close-packed mono- or bi-molecular layers. A. J. TAYLOR

535.343.2–15

5452. Infrared absorption of NiO. R. W. JOHNSTON AND D. C. CRONEMEYER. Letter in *Phys. Rev.*, **93**, 634 (*Feb.* 1, 1954).

Single crystals of NiO were produced by the Verneuil method. The crystal structure was face-centred cubic with a lattice spacing of 4·17 Å. The melting point was just over 1900°C, and the resistivity $7{\cdot}0 \times 10^6$ ohm cm. Infrared spectra were taken from 1 to 15 μ of three crystal plates of different thickness. Strong absorption above 0·3 eV is explained as the tail of the fundamental at 2 eV. A band at 0·24 eV is probably due to impurity ionization. At longer wavelengths the absorption increases because of lattice vibration absorption. A. J. TAYLOR

535.343.2–31 : 535.372

5453. Absorption and fluorescence spectra of anthracene, phenanthrene and chrysene at low temperatures. I. TSUJIKAWA AND E. KANDA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4**, 471–80 (*Oct.*, 1952).

Photographs of the near ultraviolet absorption and fluorescence spectra excited by Hg 3650 Å and 2537 Å of anthracene, phenanthrene and chrysene were taken at temperatures between room temperature and liquid hydrogen temperature. They were analysed by using the sharpening and separation of bands, and several progressions of the totally symmetrical frequencies superposed by the nontotally symmetrical ones were observed. Besides such general features of the spectrum, the lattice vibration may be taken in the fluorescence spectra of anthracene and chrysene; an anomalous change in the position of intensity maximum in some fluorescence bands of anthracene was discovered at temperatures between −196° and −253°C. A.

535.343.4

5454. The continuous absorption of light in calcium vapour. P. J. JUTSUM. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 190–1 (*Feb.*, 1954).

The atomic absorption cross-section at the series limit is $0{\cdot}45 \times 10^{-18}$ cm^2 and the variation with wavelength is found to be much more rapid than values hitherto calculated. G. F. LOTHIAN

535.343.4

5455. A note on the absorption of light by indium vapour. G. V. MARR. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 196–7 (*Feb.*, 1954).

Atomic absorption cross-sections are 10^{-16} cm^2 at the 1758 Å line and 10^{-18}–10^{-19} cm^2 at the series limit. G. F. LOTHIAN

535.343.4–14

5456. One-to-two millimeter wave spectroscopy. IV. Experimental methods and results for OCS, CH_3F, and H_2O. W. C. KING AND W. GORDY. *Phys. Rev.*, **93**, 407–12 (*Feb.* 1, 1954).

Design details are given of the harmonic generator and detector which made possible precision spectroscopy in the one-to-two mm wave region. The signal-to-noise ratio obtained on OCS rotational lines is 7 to 1 at 1·0 mm wavelength; 30 to 1 at 1·1 mm; and better than 100 to 1 at 1·4 mm and above. A useful tuning and measuring technique is made possible by the ability of the new system to detect several klystron harmonics at once and, hence, spectral lines in several different regions at the same time. The applications of the methods in the measurement of centrifugal distortion of molecules is illustrated with OCS, for which $D_J = 1{\cdot}310 \pm 0{\cdot}010$ kc/s is obtained, and with CH_3F, for which $D_J = 57{\cdot}8 \pm 1{\cdot}0$ kc/s and $D_{JK} = 445 \pm 4$ kc/s are obtained. A new water-vapour line, the $2_{2,0} \rightarrow 3_{1,3}$ rotational line, has been measured at 183 311·30 ± 0·30 Mc/s. For Pt I, see Abstr. 4713 (1953). A.

535.343.4–14

5457. Spectrum of DBr in the one-millimeter wave region. W. GORDY AND C. A. BURRUS. *Phys. Rev.*, **93**, 419–20 (*Feb.* 1, 1954).

From measurements on the $0 \rightarrow 1$ transition of DBr at 1·18 mm wavelength values of eQq(Br), B_0, B_e, r_0, r_e were obtained for $DBr^{79,81}$. Values of α obtained from infrared spectroscopy by Keller and Nielsen were employed in calculating the equilibrium values. A.

535.343.4–14

5458. Submillimeter wave spectroscopy. C. A. BURRUS AND W. GORDY. Letter in *Phys. Rev.*, **93**, 897 (*Feb.* 15, 1954).

Improved crystal multipliers and detectors enable the 16th harmonic of a 2K33 Raytheon klystron to be used for spectroscopy down to 0·77 mm where the J_{31-32} line of OCS is detected at 389041 ± 2 Mc/s. D. H. WHIFFEN

535.343.4–14

5459. Microwave spectrum of pyridine. B. BAK, L. HANSEN AND J. RASTRUP-ANDERSON. Letter in *J. chem. Phys.*, **22**, 565 (*March*, 1954).

535.343.4

5460. An investigation of the microwave spectrum pyridine. K. E. MCCULLOH AND G. F. POLLN *J. chem. Phys.*, **22**, 681–2 (*April*, 1954).

The microwave spectrum of pyridine has b observed in the region from 22 140 to 27 300 M One hundred and twenty-four lines have been fou while measured frequencies have been assigned thirty-one Q transitions and three R branch transitio From these data the molecular constants, includi those pertaining to an approximate treatment centrifugal distortion, have been evaluated.

535.343.4

5461. Dielectric behavior of methyl bromide 3-cm region. KRISHNAJI AND P. SWARUP. Letter *J. chem. Phys.*, **22**, 568–9 (*March*, 1954).

Gas absorption from 0–80 cm of Hg at 3·3 cm measured for CH_3Br and shown to arise from inversion with zero resonance frequency. D. H. WHIFF

535.343.4–14 : 539.1

5462. Microwave spectrum and molecular structu of fluorobenzene. G. ERLANDSSON. *Ark. Fys.*, *Paper* 17, 189–92 (1953).

An extension and correction to Abstr. 6634 (195 in which the distances are now given as C–C 1·404 C–F 1·294, assuming C–H 1·05 Å. D. H. WHIFF

535.343.4–

5463. Elimination of water vapour inside a spectr graph for far infrared, and the methyl alcohol spectrum A. HADNI. *C.R. Acad. Sci.* [*Paris*] **238**, 573–5 (*Feb.* 1954) *In French.*

See also Abstr. 6636 (1953). As the presence water vapour obscured completely any spectra wavelength larger than 30 μ, the whole apparatus w kept in a container, through which ran a consta flow of very dry air at low pressure. In these ci cumstances it was possible to take spectra of meth alcohol from 20 to 43 μ. The torsion oscillation the OH group was found at 249 cm^{-1}. This valu might be used for the verification of values obtaine for the potential barrier by other methods. A. J. TAYLO

535.343.4–1

5464. Induced infrared absorption in hydrogen an hydrogen—foreign gas mixtures at pressures up t 1500 atmospheres. D. A. CHISHOLM AND H. L WELSH. *Canad. J. Phys.*, **32**, 291–312 (*April*, 1954).

The pressure-induced fundamental infrared absor tion band of hydrogen has been investigated in th pure gas and in hydrogen–helium, hydrogen–nitroge and hydrogen–argon mixtures for gas pressures up t 1500 atm. and temperatures in the range 80°–376°K At the higher densities the rate of increase of th integrated absorption coefficient with density i anomalously large; this effect is interpreted in term of finite molecular volumes. The Q branch has bee shown to consist of three components Q_P, Q_Q an Q_R. The separation of the maxima in the low- an high-frequency components, Q_P and Q_R, depends o the perturbing gas and increases linearly with it density; the separation and relative intensities of th components are also strongly dependent on th temperature. It is proposed that this splitting of th Q branch is caused by the participation of the relative

netic energy of the colliding molecules in the psorption process for collisions in the region of verlap forces. The Q_Q component and the S lines ıow no splitting and are probably produced by ollisions in the region of quadrupole interaction. A.

535.343.4–15 : 535.375

465. The Raman and infra-red spectra of carbon ıboxide. D. A. Long, F. S. Murfin and R. L. Villiams. *Proc. Roy. Soc. A*, **223**, 251–66 (*April* 22, 954).

These have been redetermined, since earlier data id not permit an unequivocal decision as to the ıolecular symmetry. The infrared spectrum of the as was measured over the range 275 to 4600 cm^{-1} sing a Perkin–Elmer spectrometer. The Raman pectrum of the liquid (at −90°c) was investigated sing a photoelectric recording spectrometer. No rouble was experienced with decomposition of the ample. The purity of the suboxide which was repared from malonic acid was carefully checked by ollowing changes in the infrared and mass spectra at arious stages of the purification. In this way several ands previously attributed to the suboxide were hown to be due to impurities. Details of a normal o-ordinate treatment are given, and with its aid all he observed bands are given satisfactory assignments n the basis of a linear molecule, symmetry $D_{\infty h}$. his necessitates the postulation of one infrared active undamental at about 198 cm^{-1}. Though this lies utside the region investigated here it has been bserved by O'Loane [Abstr. 4000 (1953)]. A.

535.343.4–15 : 539.133

466. Intensities of the infrared bands of carbon uboxide. R. L. Williams. Letter in *J. chem. Phys.*, **2**, 345 (*Feb.*, 1954).

The variation of bond dipole moments with bond ength for the CO and CC bonds in carbon suboxide as been determined from intensity measurements of he ν_3 and ν_4 fundamental bands at 2264 cm^{-1} and 575 cm^{-1} respectively. G. I. W. Llewelyn

535.343.4–32

5467. New continuous spectrum connected with the ransition ($A^2\Delta - X^2\Pi$) of the CH molecule. R. Herman and L. Herman. Letter in *C.R. Acad. Sci. Paris*] **238**, 664–6 (*Feb.* 8, 1954) *In French.*

The u.v. spectra of some comets and stars show great similarity to a laboratory discharge spectrum of small quantities of CO and H_2 in xenon at 3 mm Hg pressure. Apart from the CO spectrum a continuous CH($A^2\Delta - X^2\Pi$) absorption was found, from 4400 Å to shorter wavelength. This was investigated photometrically. The maximum of the CH band occurred at 4315 Å. From experiments with a phosphorescope it was found that the excitation may be caused by a slow atomic or radiative recombination process.

A. J. Taylor

535.345

5468. Spectroscopic study of amethyst quartz in the ultraviolet and infrared regions. M. K. V. Bappu. *Indian J. Phys.*, **27**, 385–92 (*Aug.*, 1953).

A study of the absorption of light in amethyst quartz. In the ultraviolet the presence of the V-band is masked by the presence of iron impurity and it is difficult to assert its presence. That such a V-band exists was shown by Choong. In the near infrared three absorption bands are observed; the one on the long wavelength side can be identified with the M-band and the others as bands due to impurity. All these facts lead to the conclusion that the factors responsible for colour in the case of coloured alkali halides are also responsible for the coloration of amethyst quartz, with some slight difference. A.

535.345

5469. Color centers in alkali silicate glasses. R. Yokota. Letter in *Phys. Rev.*, **93**, 896 (*Feb.* 15, 1954).

Absorption bands in the visible region due to X-ray irradiation of various alkali silicate glasses are ascribed to trapped electrons in oxygen vacancies with alkali ion neighbours while the u.v. band is due to holes trapped at alkali ion vacancies adjacent to oxygen ions. G. F. J. Garlick

535.345

5470. Temperature-dependent color changes in some merocyanines. Y. Hirshberg and E. Fischer. Letter in *J. chem. Phys.*, **22**, 572–3 (*March*, 1954).

A study of the absorption spectra of several merocyanines at decreasing temperatures down to about 110°K shows that the colour changes are due to the fact that one absorption band at longer wavelength grows less intense while a second band at shorter wavelength grows more intense. W. Good

535.345 : 535.43

5471. New contributions to the optics of intensely light-scattering materials. II. Nonhomogeneous layers. P. Kubelka. *J. Opt. Soc. Amer.*, **44**, 330–5 (*April*, 1954).

The derived laws apply to layers whose scattering coefficient S and absorption coefficient K vary vertically to the surface of the layer. In the general case the differential equations of Pt I [Abstr. 2435 (1948)] must be used; the coefficients, however, hitherto constant, now are functions of the distance x from the surface. In the practically important case in which K/S is constant, one may introduce the variable p, such that $p \equiv \int_0^x S(x)dx$. One reduces thereby the nonhomogeneous to the previously treated homogeneous case. Transmittance $T_{1,2}$ and reflectance $R_{1,2}$ of two nonhomogeneous sheets can be calculated by the following equations: $T_{1,2} = T_1T_2/(1 - R_1R_2)$, $R_{1,2} = R_1 + T_1^2R_2/(1 - R_IR_2)$, where T_1, T_2, R_1, R_2 are the transmittances and reflectances of the single sheets, and R_I represents the reflectance of the first sheet when illuminated in the inverse direction. Analogous formulae for more sheets and formulae relating transmittance, reflectance for specimens upon black, grey or white backing surfaces, and contrast ratio, are derived. It is shown by theory and experiment that reflectance and absorption of a nonhomogeneous specimen depend on the direction of illumination, whereas transmittance does not. A.

535.345 : 539.234

5472. Optical properties of evaporated aluminum films. F. C. Essig and J. R. Holmes. Letter in *J. Opt. Soc. Amer.*, **44**, 253 (*March*, 1954).

Measurements of the transmission and reflection of evaporated Al films for several wavelengths are

reported, and their usefulness as mirrors in a Fabry–Perot interferometer is discussed. D. G. AVERY

535.345 : 548.7

5473. Some new observations on photochemically coloured lithium fluoride. P. PRINGSHEIM. *Z. Phys.*, **136**, *No.* 5, 573–81 (1954) *In German.*

The absorption spectrum taken at −190°c of LiF crystals coloured by exposure to X-rays shows in addition to the known bands several sharp lines [Abstr. 6646 (1953)]. Subsequent irradiation with u.v. light or heating to 100–200°c produces a considerable increase in the (initially small) intensity of the lines; treatment again with X-rays suppresses the intensities to their former values. When crystals having a high concentration of *F*-centres are heated to above 200°c the broad bands between 300 and 500 mμ break up into numerous sharp lines and groups of narrow bands which, however, are not due to the presence of rare earth salts. By heating to above 400°c all the bands and lines in the visible and u.v. regions including the otherwise strongest *F*-band at 245 mμ are completely bleached leaving only a bell-shaped band at about 270 mμ which is ascribed to colloidal particles of Li. W. GOOD

535.345 : 551.521.3

Spectral line shape and its effect on atmospheric transmissions. *See Abstr.* 6169

535.345 : 551.521.3

Regions of validity of various absorption-coefficient approximations. *See Abstr.* 6168

535.345.1–15

5474. Optical properties of silicon monoxide in the wavelength region from 0·24 to 14·0 microns. G. HASS AND C. D. SALZBERG. *J. Opt. Soc. Amer.*, **44**, 181–7 (*March*, 1954).

Using evaporation conditions adjusted for the deposition of true silicon monoxide, a series of films ranging in thickness from 0·03 to 10 μ was prepared on fused quartz, glass, rock salt and highly reflecting aluminium surfaces. The optical constants of the films were computed in the wavelength region from 0·24 to 14 μ from reflectance, transmittance and thickness measurements. Silicon monoxide films exhibit strong absorption in the ultraviolet which extends into the visible, and an infrared absorption maximum at 10 μ which differs significantly from the position of the absorption maximum of fused quartz. In the wavelength region from 0·40 to 0·70 μ, the refractive index of SiO decreases with increasing wavelength from 2·15 to 1·95. Strongly oxidized films show less ultraviolet absorption, lower indexes of refraction, and a shift of the infrared absorption band to shorter wavelength. Decomposition of SiO to Si + SiO_2 results in increased ultraviolet absorption and higher refractive indexes. In the region of the 10 μ absorption a silicon monoxide protective layer of 0·125 μ in thickness has no appreciable effect on the reflectance of a highly reflecting metallic surface, but decreases the transmittance of a rock salt plate by 30%. A.

535.345.1–15

5475. Infrared absorption of thin metal films. C. HILSUM. *J. Opt. Soc. Amer.*, **44**, 188–91 (*March*, 1954).

The maximum infrared absorption that can be obtained in an unsupported metal film in air is 50 It is shown that the absorption may be increased supporting the metal on a dielectric of high refract index, provided that the radiation passes through dielectric to the metal. Under certain conditio there is then no reflection from the layer. If combination is reversed so that the radiation incident on the metal first a low absorption resu If the supporting dielectric is of low refractive inc neither direction will lead to high absorption; in t case the use of another system, with metal on ea side of the support is preferable. Using whichever the two systems is appropriate to the supporti dielectric, an absorption of 70% is always obtainab

535.345.6 : 535.

5476. Controllable interference-type optical filt R. BLYTHE. *J. Opt. Soc. Amer.*, **44**, 336–9 (*Ap* 1954).

A transmission-type optical interference filter h been constructed which controls the colour of t light passing through it in accordance with t magnitude of a d.c. electrical signal. This is acco plished by magnetostrictively varying the separati of a pair of plane parallel quartz optical flats havi thin film coatings. The results indicate that su devices are feasible. Some theory for the filter acti is given, and data for this particular laboratory mod are shown.

535.3

5477. Moulded polystyrene scintillators. H. WAARD, W. PRINS AND A. PRINS. *Appl. sci. Res.* **3**, *No.* 4–5, 372–6 (1953).

Luminescent solid solutions of 1–4 diphen butadiene (DPB), 1–6 diphenyl-hexatriene (DPH and 1–1–4–4 tetraphenyl-butadiene (TPB) in pol styrene were made by a process of "slow" injecti moulding. DPB- and DPH-solutions thus prepar give a much larger fluorescent light output tha solutions polymerized in bulk. The fluorescence yie of a DPB-solution approaches that of the well-know TPB-plastic. Differences are also observed in t fluorescence spectra of moulded and polymerize DPB- and DPH-plastics. Little difference is observe in the fluorescence of moulded and polymeriz TPB-plastics. The poor fluorescence of the pol merized diphenyl-polyene solutions can be explain by assuming a chemical reaction in the polyene cha during the polymerization, which can not take pla in the TPB-solution, where four phenyl grou enclose the butadiene core.

535.37

5478. Energy response of some inorganic scintillator V. P. DUGGAL. *Proc. Indian Acad. Sci. A*, **38**, 320– (*Oct.*, 1953).

It is known that densely ionizing particles give ris to a non-linear energy response in organic crystal while in inorganic crystals in general the light outpu is proportional to the energy absorbed so that the is no difference between the intrinsic efficiencies fo α-particles and γ-ray excitation. The study of som inorganic silicate scintillators reported here show however, that they resemble the organic crystals i

eir non-linear energy response. Contrary to the ehaviour of organic scintillators, prolonged α-ombardment does not produce any perceptible hange in the fluorescence efficiency of these scintil-tors. The non-linear energy response of these licates is not explainable by the mechanism of intillation hitherto proposed. A.

535.371

479. A new quenching effect in liquid scintillators. . W. PRINGLE, L. D. BLACK, B. L. FUNT AND . SOBERING. Letter in *Phys. Rev.*, **92**, 1582–3 (*Dec.* 5, 1953).

Removal of dissolved oxygen from *p*-terphenyl/ylene solutions doubles the scintillation pulse heights. ddition of diphenyloxazole also improves the cintillation efficiency. G. F. J. GARLICK

535.371

480. On the hydrogen model for traps (Bethe odel). D. CURIE. *C.R. Acad. Sci.* [*Paris*] **238**, 79–81 (*Feb.* 1, 1954) *In French.*

535.371

481. Photofluorescence and scintillations. M. AGENO. Letter in *Nuovo Cimento*, **11**, 318–20 (*March*, 954) *In Italian.*

A criticism of Birks' theory of scintillation, especi-lly as regards the assumed repeated absorption and mission of photons of decreasing energy. The verlap of the absorption and emission spectra, and he existence of energy transport over large distances, re in favour of the theory for the final phase of bsorption in macroscopic organic crystals; but the ssumption [Abstr. 321 (1954)] of identity between he mean life of photoluminescence in the molecule nd that in microcrystals is questioned, since the ossible existence of energy transport over small istances has not been considered. The large number f efficient photoluminescent phosphors which do not how scintillations indicates that in the first phase of he absorption process the amount of direct excitation y fast particles is very small. It is desirable that the rimary photons postulated by Birks should be emonstrated experimentally. S. T. HENDERSON

535.371

5482. Measurement of organic fluorescence decay imes. C. F. RAVILIOUS, R. T. FARRAR AND S. H. IEBSON. *J. Opt. Soc. Amer.*, **44**, 238–41 (*March*, 954).

In past measurements, the decay times of scintilla-ions produced in organic scintillators by γ-rays nd the decay times of fluorescence excited by ultra-violet radiation have been determined by a self-cancellation method and a fluorometer, respectively. The results of these measurements indicated that, in general, the ultraviolet decay times were only about one-half as large as those obtained by scintillation measurements. To check the fluorometer method, the decay times of some fluorescent dyes (fluorescein, rhodamine *B*, and erythrosin) dissolved in glycerine were measured both by a modified version of the fluorometer and by observation of the depolarization of the fluorescence. The values thus obtained were found to agree within experimental error, which corroborated the previous observation of discrepancies between decay times derived from fluorometer and scintillation measurements. A.

535.371

5483. The long-lived phosphorescent components of thallium-activated sodium iodide. C. R. EMIGH AND L. R. MEGILL. *Phys. Rev.*, **93**, 1190–4 (*March* 15, 1954).

Using a cobalt-60 source as a means of primary irradiation, the long-lived phosphorescent decay of thallium-activated sodium iodide crystal has been studied at several crystal temperatures. The results have been interpreted assuming that the different trap levels act independently of each other and that each trap decays according to the monomolecular process. Values for the experimental trap depths and vibrational frequency factors are given. A.

535.371 : 537.525

5484. The band fluorescence of mercury vapor. A. O. MCCOUBREY. *Phys. Rev.*, **93**, 1249–60 (*March* 15, 1954).

The band fluorescence of mercury vapour excited by the 2537 Å atomic line has been studied during the afterglow. Time sampling techniques were employed to overcome difficulties attending the measurement of very low-intensity radiations. The two main band constituents (centred at 4850 Å and 3350 Å) were found to decay simultaneously under all conditions investigated. The temporal structure of the decaying fluorescence was found to be characterized by two time constants and has the form associated with chain type reactions. The two time constants and the relative intensities of the 4850 Å and 3350 Å bands were measured for a range of vapour densities at a fixed vapour temperature. In order to evaluate the role of diffusion in the lifetime of the excited particles involved, measurements were made in vessels of two different sizes. The experimental results have led to an interpretation according to which the optically excited $Hg(^3P_1)$ atoms are converted into metastable $Hg(^3P_0)$ atoms by inelastic collisions. The $Hg(^3P_0)$ atoms are then converted in a three-body collision reaction to metastable $Hg_2(^3O_u^-)$ molecules which, in turn, may be destroyed in the vapour by either one of two processes, i.e. by spontaneous radiation to the ground state, giving rise to the 3350 Å band, or by a second three-body collision through which the emission of the 4850 Å band is induced. An analysis based upon this picture has permitted the quantitative evaluation of several properties of the particles involved. The diffusion coefficient of the $Hg(^3P_0)$ atom was found to be 210 cm²/sec for a density of 10^{16} atoms/cm³ and a temperature of 200°C; the diffusion coefficient of the $Hg_2(^3O_u^-)$ molecules is 88 cm²/sec under the same conditions. The spontaneous radiation rate of the $Hg_2(^3O_u^-)$ molecules is 20 sec^{-1} and the three-body collision induced radiation rate is 21×10^{-32} $(atoms/cm^3)^{-2}$ sec^{-1}. The three-body destruction rate for the $Hg(^3P_0)$ atoms is 100×10^{-32} $(atoms/cm^3)^{-2}$ sec^{-1}. It was also found that the $Hg_2(^3O_u^-)$ molecules are approximately 90% reflected by the glass walls of the enclosure. The diffusion coefficient obtained for $Hg(^3P_0)$ atoms is in agreement with the results of other work and the three-body collision rates are comparable with those for similar processes investigated elsewhere. A.

535.375.5 : 539.132

5485. Raman spectra and potential constants for CF_3Cl, CF_3Br, and CF_3I. R. C. TAYLOR. *J. chem. Phys.*, **22**, 714–16 (*April*, 1954).

Raman frequencies have been obtained for gaseous CF_3Cl and CF_3Br and for liquid CF_3I at −40°C. The assignments are in agreement with previous investigations. The spectra have been analysed using a simplified, six-constant potential function of the Urey–Bradley type without the assumption of tetrahedral angles round the central carbon atom. In all three cases, it was found possible to reproduce the experimental frequencies to within less than their experimental error. A.

535.375.54 : 539.133

5486. Raman spectrum and orientation of water molecules in the crystals of oxalic acid dihydrate. A. WEIL. *C.R. Acad. Sci.* [*Paris*] **238**, 576–8 (*Feb.* 1, 1954) *In French.*

The bond angles in the water molecules and the relative disposition of the acid and water molecules may be determined by interpretation of the Raman spectrum of a monocrystal of $C_2O_4H_2 . 2H_2O$.

G. I. W. LLEWELYN

535.375.56

5487. On the Raman spectra of 1,2-dichloroethane and 1, 1,2-trichloroethane in the vapour state. M. MAZUMDER. *Indian J. Phys.*, **27**, 406–14 (*Aug.*, 1953).

The ratio of intensities of the lines 755 and 654 cm^{-1} in the Raman spectrum of 1, 2-dichloroethane vapour at 135°c was measured quantitatively and compared with that reported for the vapour at 170°c by previous workers. It was observed that a catastrophic change in the intensity ratio takes place with the change of state from liquid to vapour phase. The values of the intensity ratio, however, change only very slightly with the change of temperature of the vapour from 135°c to 170°c, so that the difference in energies of the two types of molecules to which the two lines are attributed remains the same in the case of the vapour as in the case of the liquid. It is pointed out that the catastrophic change in the intensity ratio cannot be explained on the assumption that two types of molecules co-exist in the liquid, the relative populations of the molecules depending on their partition functions and energy difference, and that some sort of stronger interaction between the molecules in the liquid state is to be postulated to explain the apparently anomalous results. In the case of 1, 1, 2-trichoroethane the line 775 cm^{-1} for the liquid at 120°c is totally absent in the spectrum due to the vapour at 170°c. It is pointed out that this change takes place with the change from liquid to the vapour state. Probable explanations for this phenomenon are offered. A.

535.375.56

5488. On the Raman spectra and fluorescence of ortho and parachlorotoluene in the solid state. S. B. SANYAL. *Indian J. Phys.*, **27**, 447–51 (*Sept.*, 1953).

The Raman spectra at −180°c were photographed and compared with those for the liquids at room temperature. Four new lines in the low-frequency region were observed in each, two of them having almost the same frequencies in both substances. The intensities of these new lines are much smaller than those of the prominent lines due to the liquids. is further observed that in the case of *o*-chlorotolue some of the prominent Raman lines observed for t liquid state undergo large changes in intensity a position and the line 2928 cm^{-1} splits up into thr lines when the liquid is solidified and cooled −180°c. It is suggested that the line 163 cm^{-1} liquid *o*-chlorotoluene which shifts to 185 cm^{-1} the case of the solid might be due to a dimer. It observed that these substances exhibit broad inter fluorescence bands in the visible region in the so state at −180°c, and in the liquid state there is fluorescence in the case of *p*-chlorotoluene, but chlorotoluene shows a continuous fluorescence in t whole visible region.

535.3

5489. The electroluminescence of various phospho and its dependence on the strength and frequency of t electrical alternating field. H. GOBRECHT, D. HA AND H. E. GUMLICH. *Z. Phys.*, **136**, *No.* 5, 612– (1954) *In German.*

The phosphors used included ZnO, also ZnS.Z and ZnS.Ag which had been rendered much mo responsive by heating in air to produce a 10–20 oxide content. This treatment changed the bl luminescence to green. A cell with liquid dielectr was used, and the electroluminescence found increase with temperature decrease to −100°c. F a field E the light intensity was given by $AE^n\exp(-B/$ where A, B and n are constants and $n \simeq 2$. Resul are shown and discussed for the waveforms of lig emission at different voltages and frequencies, a for the emission intensity with the same variable The cause of saturation with frequency is considere and means of distinguishing true electroluminescen from the effects of glow discharges given.

S. T. HENDERS

535.3

5490. Examination of energy exchange and quench ing processes in gases due to excitation with fa particles. A. E. GRÜN AND E. SCHOPPER. *Naturforsch.*, **9a**, 134–47 (*Feb.*, 1954) *In German.*

Dependence of scintillation light yield is examine photoelectrically for N_2 and N_2-gas mixtures (A, X O_2, etc.) excited by α-particles. Quantitative conclu sions are deduced for energy exchange in gas mixture due to secondary electrons and for the quenchin process in N_2. G. F. J. GARLIC

535.39

5491. The structure and optical behaviour o iridescent agate. C. V. RAMAN AND A. JAYARAMAN *Proc. Indian Acad. Sci. A*, **38**, 199–206 (*Sept.*, 1954).

A detailed study has been made by optical and X-ra methods of two plates of banded agate which displa iridescence over part of their area. The light trans mitted by the banded areas is found to be completel polarized with the vector normal to the planes o banding. On the other hand, the wavy superpositio patterns exhibited by the iridescent areas disappea for the same vibration direction. From these fac and the observed optical characters of the diffusio and diffraction phenomena it is deduced that th crystallites of quartz form fibres elongated in th direction of a crystallographic *a*-axis, while thei

principal or *c*-axes lie in the planes of banding but are orientated in a periodic manner in these planes so as to build up a structure which functions as a diffraction grating. The X-ray results support these findings. More generally also, they indicate that the banding of agate is a consequence of the presence in it of groups of crystallites of quartz having common specific orientations. A.

535.391

5492. The structure and optical behaviour of iridescent crystals of potassium chlorate. C. V. RAMAN AND D. KRISHNAMURTI. *Proc. Indian Acad. Sci. A*, **38**, 261–70 (*Oct.*, 1953).

Iridescent crystals of potassium chlorate exhibit geometric patterns of reflection and extinction respectively when a field of diffuse monochromatic light is viewed by reflection at or transmission through the crystal. The patterns consist in general of four closed curves, two of which are polarized with their vibration directions parallel to the plane of symmetry of the crystal and the two others perpendicular thereto. The configuration of the patterns exhibits a perfect concordance with the spectral character of the reflections or extinctions observed with incident white light at corresponding azimuths of incidence and thus furnishes a complete picture of such spectral behaviour. Photographs of the geometric patterns are reproduced with the paper as also of the conoscopic patterns exhibited by the iridescent crystals on the stage of a polarizing microscope. The paper also reports the observation that the twinned crystals of potassium chlorate function as diffraction gratings and give polarized spectra when light traverses them along their composition planes of twinning. A.

535.391

5493. The structure and optical behaviour of iridescent opal. C. V. RAMAN AND A. JAYARAMAN. *Proc. Indian Acad. Sci., A*, **38**, 343–54 (*Nov.*, 1953).

The X-ray investigation of the structure of the cryptocrystalline hyalites reported in Abstr. 347 (1954) has been revised using cameras of higher resolving power. Precise measurements of the resulting photographs reveal that low-tridymite and high-cristobalite are present associated with each other in this material. Investigation of the structure of common opal exhibiting a waxy lustre leads to similar results. From a detailed examination of the diffuse X-ray patterns given by gem-opals as well as a comparative study of the iridescent hyalites and opals, it is concluded that in both of these materials, the presence of alternating layers of high-cristobalite and low-tridymite is responsible for the iridescence. A.

535.391

5494. The structure and optical behaviour of chalcedony. A. JAYARAMAN. *Proc. Indian Acad. Sci. A*, **38**, 441–9 (*Dec.*, 1953).

Common chalcedony and agate, when examined by methods similar to those employed in the case of iridescent agate [Abstr. 5491 (1954)] exhibit analogous features. The transmission and diffusion of light, their polarization characters and the influence of the thickness of the medium on these features are discussed from a theoretical standpoint. The results are borne out by observations made with several specimens of agate and chalcedony. The lamellar structure which is often exhibited by chalcedony is found to arise from the orientation of the *c*-axes of the crystallites of quartz in the fibres along the banding planes which run transversely to the former. X-ray patterns of chalcedony in such regions reveal that the crystallites of quartz are orientated with their *a*-axes common along the fibre length. A.

535.392 : 531.717

5495. On the interference color of a dielectric layer on metal surface. S. NAWATA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 179–84 (*April*, 1953).

The interference colour of an Al mirror covered with ZnS was calculated and plotted on the I.C.E. chromaticity diagram in order to study the interference colour of a dielectric layer on a metal surface. When a very thin Al film was evaporated again upon the mirror Al(opaque) + ZnS, the interference colour of this mirror became very vivid. The spectral reflectivity of the mirror: Al(opaque) + ZnS + Al (very thin), was measured by a spectrophotometer taking the optical thickness of ZnS as parameter and the results of calculation of the interference colour were plotted on the I.C.E. chromaticity diagram. Results observed by eye were compared with spectrophotometer results and it was observed that when the thickness of Al film became thicker than ~ 40 Å, the interference colour changed from the initial state and the change of colour went in the opposite direction. On the basis of these results, the method of coating ZnS layer with an accurate thickness of $\lambda/4$ or MgF_2 layer with $\lambda/2$, was discussed. In this method by using the substratum of Al mirror, the observation of interference colour change was very easy and no analyser was necessary in the observation. A.

535.392 : 539.23

5496. Multiple thin dielectric films as mirrors and interference filters. A. VAŠÍČEK. *Czech J. Phys.*, **3**, 206–22 (*Sept.*, 1953).

Thin non-metallic films on a glass surface having alternately high and low refractive indices strongly increase the reflectance of coated glass, so that they may completely replace the current metallic mirrors. Multiple thin transparent films are used in the production of interference filters having narrow bandwidth and great transmission. The author theoretically solves the problem of the reflection of light from glass with thin alternate films and examines the conditions for the application of multiple thin non-metallic films in optical practice, producing very effective mirrors and interference filters having narrow bandwidth. A.

535.41

5497. Limit of interference in optical instruments. A. N. NIGAM, Y. P. VARSHNI AND M. S. SODHA. *Indian J. Phys.*, **27**, 491–5 (*Oct.*, 1953).

A rigorous theory is given for the limit of interference in Lummer Gehrcke plates, transmission and reflection echelons and the grating on the lines of Saha's treatment for the Fabry–Perot interferometer. A.

535.41

5498. Use of high contrast in the photography of interference fringes. D. S. BROWN. Letter in *Nature [London]*, **173**, 443 (*March* 6, 1954).

It is pointed out that fringes from two-beam interferometry can be sharpened up by suitable photographic techniques using high photographic contrast.

S. TOLANSKY

535.41

5499. The evaluation of interferograms by displacement and stereoscopic methods. J. W. GATES. *Brit. J. appl. Phys.*, **5**, 133–5 (*April*, 1954).

A method of obtaining pairs of interferograms is described which makes possible the accurate and rapid evaluation of the optical path variations in the system tested. Such a pair of two-beam interferograms may be measured by displacement methods to an accuracy of about 0·002 wavelength if the path variations are small, or the pair may be viewed stereoscopically to give an impression of the path variation from point to point over the whole area. A.

535.41 : 541.183.022

5500. Fringes of equal reflection coefficient ratio and their application to the determination of the thickness and refractive index of monomolecular films. I. Theory. R. E. HARTMAN. *J. Opt. Soc. Amer.*, **44**, 192–6 (*March*, 1954).

A class of spectral fringes, families of which are produced by use of surfaces having equal reflection coefficient ratios, can be demonstrated by use of a suitable polarizing assembly and spectrometer. The theory of these fringes and their use in the determination of both the thickness and refractive index of monomolecular films is discussed. A.

535.41 : 541.183.022

5501. Fringes of equal reflection coefficient ratio and their application to the determination of the thickness and refractive index of monomolecular films. II. Determination of the thickness and refractive index of barium stearate double layers. R. E. HARTMAN, R. S. HARTMAN, K. LARSON AND J. B. BATEMAN. *J. Opt. Soc. Amer.*, **44**, 197–8 (*March*, 1954).

A method is described for determining the thickness and refractive index of barium stearate double layers. Films prepared by the method of Blodgett, but using a different piston oil, were found to have a thickness of 45·7 Å and an ordinary refractive index of 1·508. A.

535.417

5502. In-line interferometer. J. B. SAUNDERS. *J. Opt. Soc. Amer.*, **44**, 241–2 (*March*, 1954).

An interferometer is described for the measurement of beam dividing surfaces. The apparatus consists essentially of the elements for a Twyman–Green interferometer. The end mirrors are made of optical glass and the reflecting surfaces of these mirrors transmit a part of the beam. The advantages of the instrument are (*a*) a sensitivity $(n + 1)$ times that of the Fizeau viewer, which is usually used for this test, (*b*) compactness, and (*c*) robustness. A.

535.417

5503. Characteristics of the series interferometer. D. POST. *J. Opt. Soc. Amer.*, **44**, 243–9 (*March*, 1954).

Basically, the series interferometer consists of three partially reflective surfaces separated by approximate equal optical distances. Some of the properties this instrument are discussed, and some comparisons are drawn between the series interferometer and mo complicated systems of similar versatility. Distin low-order fringes are produced and the instrume may be constructed to permit observation of whit light fringes. Background intensity is superimpose upon the fringe patterns obtained with paral mirror setups, but can be eliminated by using slight inclined mirror systems. Optimum performance f inclined mirror instruments yields a peak frin intensity of 14·8% of the incident intensity. Th fringe pattern is localized in or near the first mirr surface for most applications of the instrumen Experimental observations are presented to indica the character of interference patterns obtained wi normal and oblique incidence. The series interfer meter is shown to be a compact, stable instrume capable of measuring minute variations of optic paths in a wide range of applications.

535.4

5504. Selection of the separation of the plates of th Fabry–Perot interferometer. J. BLAISE, H. CHANTRE P. GIACOMO AND D. A. JACKSON. Letter in *J. Opt Soc. Amer.*, **44**, 253–4 (*March*, 1954).

When using a Fabry–Perot interferometer for th analysis of a complex hyperfine structure patter extending over a wide spectral range there is one mos favourable interferometer plate separation whic reduces overlapping to a minimum and gives max mum resolution. A description is given of a simpl cardboard template technique permitting the bes separation to be decided upon for a structure which already reasonably well-known. S. TOLANSK

535.417 : 534.15

5505. Calibration of sensitive vibrometers by inter ferometry. C. F. BRUCE, J. A. MACINANTE AND J. C KELLY. *Austral. J. appl. Sci.*, **4**, 28–46 (*March*, 1953)

An account is given of the direct calibration b multiple-beam interferometry of an experimenta capacity vibrometer. The theory and technique o the interferometric method are given, and the effect of the duration and frequency of the light pulses and of the frequency stability are discussed. The con struction of the vibrometer and vibrating table i described. For small vibrations whose double amplitudes are less than 0·25 μ or 10^{-5} in. (half a wavelength of light), a precision of well within 0·002 μ (10^{-7} in.) was obtained by using continuous light sources and measuring the width of broadened inter ference fringes. For larger vibrations, interrupted sources of light are used to obtain a stroboscopic motion of the fringes. In this way double amplitudes of up to 12·5 μ (0·0005 in.) were measured with a precision of the order of 0·025 μ (10^{-6} in.). Methods of extending the range are suggested. A.

535.433

5506. The problem of Fraunhofer scattering by an optically continuous transparent and three-dimensional screen and its possible applications. N. N. GUPTA. *Proc. Nat. Inst. Sci. India*, **19**, 511–17 (*July–Aug.*, 1953).

The general problem of Fraunhofer scattering by a three-dimensional continuous and transparent medium

has been mathematically solved and its physical application is discussed. It is seen that at lower angles the general intensity equation is transformed into well-known Guinier's intensity equation of X-ray low angle scattering. A.

535.434

5507. The colour of colloidal silver and Mie's theory. E. WIEGEL. *Z. Phys.*, **136,** *No.* 5, 642–53 (1954) *In German.*

The extinction values as a function of wavelength were determined for aqueous Ag sols of varying particle size (prepared by adding various amounts of a highly dispersed Carey Lea sol to H_2O_2). Each sol shows a pronounced maximum absorption which, with simultaneous broadening and weakening, lies more and more towards the red the greater the particle size. The colour of the scattered light is in qualitative agreement with Mie's theory for spherical particles. The theory, however, predicts that with sols of large particle size the transmitted colour should be grey whereas it is found to be vivid blue and violet. Electron microscope observation of the sol particles shows them to be plate-like crystallites and this deviation from spherical form is, in accordance with Gauss' extension of Mie's theory, given as the reason for the transmission of blue and violet. W. GOOD

535.5.08

5508. Two simple methods of measurement of the rate [degree] of polarization of light. P. DRZEWIECKI, A. JABŁOŃSKI, A. KAWSKI AND M. KRYSZEWSKI. *Acta phys. Polon.*, **12,** *No.* 2, 149–51 (1953).

Two experimental arrangements are described which require no special devices such as double image prisms, Savart plates, etc. A.

535.51 : 512.831

5509. Matrix calculus and the Stokes parameters of polarized radiation. M. J. WALKER. *Amer. J. Phys.*, **22,** 170–4 (*April*, 1954).

The specification of the state of polarization of beams of radiation by Stokes parameters is discussed. Mueller's method of regarding the Stokes parameters as column matrices and optical devices as represented by 4×4 matrices is described and examples of the procedure are given. The relation of the Stokes parameters to the Poincaré sphere representation is shown. A.

535.542.1

5510. A quarter-wave compensator with a sensitive half-shadow device. H. G. JERRARD. *J. Opt. Soc. Amer.*, **44,** 289–96 (*April*, 1954).

Details are given of an instrument capable of measuring large and small optical phase differences between the components of an elliptically polarized radiation. The lowest limit is between 10^{-4} and $10^{-5}\times 2\pi$. The compensator consists of an accurate quarter-wave plate (Sénarmont compensator) for the wavelength used (5461 Å) and a Nakamura half-shadow device. The quarter-wave plate, suitably orientated, reduces the elliptically polarized light to a linearly polarized vibration, the azimuth of which is simply related to the phase difference. The azimuth is determined with a Glan–Thompson polarizing prism. The full theory is given with special reference to possible sources of error. These are calculated for a series of values. An expression for the half-shadow sensitivity is found. The methods of use and of construction are fully described. The instrument is particularly suitable for the measurement of streaming double refraction. A.

535.55

5511. On the photoelastic constant of glass under large stresses. G. M. BARTENEV. *Dokl. Akad. Nauk SSSR*, **91,** *No.* 3, 523–6 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-170.

The usual breaking strength of glass is about 550 kg cm^{-2} and measurements of photoelastic constants by bending a glass bar have been limited to this figure. The strength of the bar may be increased by etching with 35% hydrofluoric acid: the maximum strength is about 2500 kg cm^{-2} for a depth of etching of about 0·3 mm. The photoelastic constant was measured for several glasses for stresses from 0 to 2500 kg cm^{-2}. It is independent of stress over this range showing that glass obeys Hooke's Law up to this value, and possibly higher. The constant is given as $2\cdot5\times10^{7}$ cm^2 kg^{-1} to within 3%.

H. G. JERRARD

535.557 : 532.7 : 541.64

5512. Flow birefringence in solutions of macromolecules. R. CERF AND H. A. SCHERAGA. *Chem. Rev.*, **51,** 185–261 (*Oct.*, 1952).

A specialist review of the subject, covering methods of investigation and apparatus, recent developments for solutions of rigid and chain molecules, tests for validity of the different models, behaviour at high velocity gradients, effect of electric charges, relaxation times. Bibliography of 197 entries.

535.65

5513. A comparison of three methods for color scaling. R. M. HALSEY. *J. Opt. Soc. Amer.*, **44,** 199–206 (*March*, 1954).

This investigation is concerned with the amount of agreement among perceptual colour scales constructed from liminal differences, large psychological intervals, and absolute judgment data. These comparisons were made for the same observers and for constant viewing conditions. Scales were constructed for mixtures of yellow and blue primaries produced by filtered light, at constant luminance. Each of five observers completed three experiments from which colour scales were derived: successive bisection, yielding an equal-interval scale; colour matching, yielding an integrated just-noticeable difference scale; and absolute judgment, yielding an equal-discriminability scale. Very good agreement was found between the just-noticeable difference and equal-discriminability scales for all observers. The correspondence between the bisection scales and the other scales ranged from very good to very poor for different observers. A.

535.65

5514. Fundamental response functions and binocular color matching. W. L. BREWER. *J. Opt. Soc. Amer.*, **44,** 207–12 (*March*, 1954).

A method is described for determining the fundamental response functions of the Young–Helmholtz three-receptor hypothesis by means of binocular colour matching data. The method is an extension

of the methods described previously by Wright and by Walters. Data supplied by Burnham, Evans and Newhall are used to determine a set of the functions. These results are compared with those obtained previously in adaptation experiments and with those implied by results of colour blindness investigations. A.

535.65

5515. A visual tricolorimeter using the C.I.E. stimuli X, Y, and Z. R. W. G. Hunt. *J. sci. Instrum.*, **31**, 122–4 (*April*, 1954).

By arranging for each knob of a visual tricolorimeter to vary simultaneously and in the same proportions the intensities of both a beam in the comparison mixture and a desaturating beam in the test field, it is possible to use matching stimuli which are effectively outside the spectral locus. By suitable choice of the colours of the comparison and desaturating beams controlled by each knob, the effective matching stimuli can be the C.I.E. stimuli **X**, **Y** and **Z**. In the case of the **X** and **Z** stimuli the luminances of the comparison and desaturating beams are equal, so that when a test colour is matched all its luminance has to be balanced by that of the **Y** stimulus. A colorimeter of this type has been constructed and is shown to give substantially correct results. Its practical advantages are described, and its usefulness in teaching the C.I.E. system is emphasized. A.

535.65

5516. A colorimeter for pyrotechnic smokes. I. Nimeroff and S. W. Wilson. *J. Opt. Soc. Amer.*, **44**, 299–302 (*April*, 1954). Also in *J. Res. Nat. Bur. Stand.*, **52**, 195–9 (*April*, 1954).

A tristimulus photoelectric colorimeter has been designed to measure the chromaticities of pyrotechnic smokes having highly saturated colours. To obtain a compact housing for three multiplier phototubes, "head-on" type (RCA 5819) phototubes are used. For high sensitivity and stability the photometric units are three Photovolt Multiplier Photometers, Model 520-M. To minimize edge effects and rear wall reflection, the smoke chamber was designed as a 36 in. cube. The chamber is illuminated by four 150 W flood lamps placed to yield uniform illumination on the viewing window. Three filters were designed to approximate the daylight C.I.E. standard observer functions for the source-filter-phototube combinations of the instrument. As the C.I.E. $\bar{y}$ and $\bar{z}$ functions are unimodal, little difficulty was encountered in designing the filters to approximate these functions. The C.I.E. $\bar{x}$ function, which is bimodal, required a divided filter to approximate its two lobes. The filter constructed was composed of two sectors, one approximating the "blue lobe," the other approximating the "red lobe," of the $\bar{x}$ function. Satisfactory results have been obtained with this colorimeter using Munsell papers as standards. A.

535.662 : 539.26

X-ray study of colloidal coloured glass. *See Abstr.* 6037

535.662 : 539.26

Colloidal coloured silica glass. *See Abstr.* 6038

535.662 : 539.26

Colloidal coloured silver glass. *See Abstr.* 6039

535.7 : 612.8

Physiological optics *See Abstr.* 6194–200

535.822

5517. Interference microscopy at high wedge angle H. Mykura. *Proc. Phys. Soc.* [*London*] *B*, **67**, 281– (*April*, 1954).

Methods available for interference microscopy o opaque objects at high wedge angles are discusse and formulae for interpreting interferograms an derived. Fringes can be resolved with wedge angl up to 30° both with the Zeiss–Linnik interferenc microscope and with an ordinary bench microscop using an oil immersion lens and parallel illuminatio (Fizeau system). The accuracy with which thes angles can be measured is poor, about 10% for th highest angle resolvable, but the accuracy increase proportionately with decrease of angle. Some inte ferograms illustrating the capabilities and drawback of the methods are given. A

535.8

5518. Investigations concerning light sources fo spectrum analysis. II. Electronically controlled a.c operated d.c. interrupted arc source. Á. Bardócz *Acta phys. Hungar.*, **2**, *No.* 4, 265–76 (1952).

For Pt I, see Abstr. 8829 (1952). The interrupte arc source, of otherwise conventional circuit, can b ignited at a variable frequency, i.e. the number o arcs per unit of time can be varied. The high voltag and high frequency ignition is achieved by a thyratro circuit with a Tesla transformer inserted. Th frequency of the ignition can be adjusted by con trolling the thyratron grid. The grid is controlled b voltage pulses coming from a pulse generator. A

HEAT 536

536.2

5519. Thermal convection in laminary boundary layers. I. H. J. Merk and J. A. Prins. *Appl. sci. Res. A*, **4**, *No.* 1, 11–24 (1953).

The heat loss of a hot body with constant surface temperature by thermal convection in a laminary boundary layer is described by partial differential equations. These can only be reduced to ordinary differential equations if the temperature and velocity profiles at any two points are similar. This leads to a geometrical condition that is given here for cases of two dimensional and of rotational symmetry. Some examples of the resulting equations are worked out in first approximation. The horizontal cylinder and the sphere do not satisfy the condition, but the flow in the neighbourhood of their lower stagnation points may be found approximately in just the same way. The results of other authors are discussed and extended. A.

536.2

5520. Thermal convection in laminar boundary layers. II. H. J. Merk and J. A. Prins. *Appl. sci. Res. A*, **4**, *No.* 3, 195–206 (1954).

It is shown that a refinement of the Squire–Eckert approximation for the thermal convection in laminar

oundary layers leads to better agreement with the gorous solution, due to Schuh, than the Saunders pproximation, used in Pt I. A.

536.2

5521. Thermal convection in laminar boundary ayers. III. H. J. MERK AND J. A. PRINS. *Appl. sci. Res. A*, **4**, *No.* 3, 207–21 (1954).

The exact value of the heat loss in laminar thermal onvection at the surface of horizontal cylinders and pheres is as yet difficult to calculate explicitly with he aid of the so-called exact boundary layer theory. The local heat transfer is therefore calculated by an pproximation method first introduced by Squire for a flat plate. The calculations are performed for horizontal cylinders and spheres in first approximation for some values of the Prandtl number between 0·7 and ∞ and in second approximation for $Pr = \infty$. The results look reasonable in themselves, while the total heat transfer is in rather good agreement with experiment, especially for a horizontal cylinder in air. This more or less justifies the approximations introduced. Some details of the second approximation are given for large values of the Prandtl number and compared the theoretical results for different shapes of the body. A.

536.2

5522. The contribution of radiation to the conduction of heat. II. Boundary conditions. E. F. M. VAN DER HELD. *Appl. sci. Res. A*, **4**, *No.* 2, 77–99 (1953).

In Pt I [Abstr. 7213 (1952)] the boundary conditions were left out of consideration. The present part deals with the boundary conditions in the stationary cases, the non-stationary problems being as yet too complicated to be solved generally. If the surfaces of a body are sufficiently far apart, the phenomena at the surfaces can be described by a transmission coefficient α_0, which in the dimensionless form $\alpha_0/\lambda_m\varepsilon$ is only a function of properties of the materials used (emissivity of the bounding materials, ratio of absorption and scattering in the body and ratio of pure and radiant conductivity). Its influence can only be lowered by changing these properties, but cannot be completely suppressed. In thin layers (optical thickness smaller than $10/\varepsilon\phi$) the influence of both surfaces has to be taken into consideration. The integro-differential equations controlling the phenomena and approximate solutions are given. Theory and experiments are in agreement. As an example kapok (weight $\rho \geqslant 0{\cdot}0017$ g/cm^3) is investigated: $\varepsilon = 794\,\rho$; $\phi = 0{\cdot}20$ (i.e. 20% of the extinction coefficient is absorption and 80% is scattering). A.

536.2

5523. Thermal conductivity measurements on inert media using internal calorimetry. A. L. HAIGH. Letter in *Nature* [*London*] **173**, 493–4 (*March* 13, 1954).

The method consists in noting the steady temperature of a fine-gauge heated thermocouple, embedded in the medium, as a function of the wattage in the heater. The accuracy for solids and semisolids was good but was greatly reduced for liquids. Vaseline behaved as if its thermal conductivity decreased on heating. L. G. CARPENTER

536.21

5524. Optimum problems in the conduction of heat in a semi-infinite solid. H. A. LAUWERIER. *Appl. sci. Res. A*, **4**, *No.* 2, 142–52 (1953).

A semi-infinite solid of zero temperature is heated by applying a constant temperature T_0 or a constant flux Q_0 at the boundary. After t_0 seconds the boundary is insulated. At a given place x inside the solid it is required to reach a prescribed temperature T_m with a minimum of energy input. Optimum conditions for T_0, Q_0 and t_0 are given, and the total energy input is calculated. Minimum heat supply is only possible for a "heat explosion" $t_0 \to 0$. A.

536.212.2

5525. The thermal conductivity of metals. R. E. B. MAKINSON. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 290–1 (*March*, 1954).

It is shown that Sondheimer's expression for the thermal conductivity [Abstr. 8687 (1950)] is stationary for small variations of the distribution function from its correct value. E. H. SONDHEIMER

536.24

5526. Heat transfer in laminar flow through cylindrical tubes. J. SCHENK AND J. M. DUMORÉ. *Appl. sci. Res. A*, **4**, *No.* 1, 39–51 (1953).

The problem of heat transfer occurring when a hot liquid passes in laminar flow from a hot into a cold tube is reviewed and the solution extended to the case of finite transmissivity of the tube wall. Calculations have been carried out for three finite values of the dimensionless number $Nu' = k'D/\lambda$. The graphs thus obtained allow interpolation for all values of Nu' from 0 to ∞. A simple method for calculating the total Nu for arbitrary cases is suggested. Finally some mathematical properties of the differential equations and the functions occurring in this problem and in the analogous problem of heat transfer in flow between parallel plates are summarized. A.

536.24

5527. Non-uniform heat transfer to fluids flowing in conduits. V. J. BERRY, JR. *Appl. sci. Res. A*, **4**, *No.* 1, 61–75 (1953).

The general theory of the temperature distribution in a fluid flowing in a heated conduit is discussed. Equations are derived for the temperature distribution throughout the fluid stream, and an expression is presented for the Nusselt modulus as a function of downstream position. A definite criterion is proposed for estimation of the thermal entry length. In addition, it is shown that the asymptotic value of the Nusselt modulus depends not only upon the geometry and the hydrodynamics of the system, but also upon the temperature boundary conditions imposed. A simple procedure is given for computation of the heat transfer coefficient when velocity and effective thermometric conductivity distributions are available. Both round pipes and parallel wall conduits are considered. A.

536.24

5528. Diffusion from a source in a skew velocity field. H. A. LAUWERIER. *Appl. sci. Res. A*, **4**, *No.* 2, 153–6 (1953).

The following diffusion problem which is of interest

in problems on heat and mass transfer has been solved. A fluid flows with a non-uniform velocity $v_0(1 + ay)$ in the x-direction of an x, y plane. The origin is a source of constant strength. For the boundary condition $c = 0$ at $y = -1/a$ the diffusion equation can be solved in an explicit form. A slightly skewed normal distribution function is obtained. A.

536.24

5529. The effect of fluid motion on heat transmission. II. Determination of the forced convection constant. D. G. KAPADNIS. *Indian J. Phys.*, **27**, 533–40 (*Nov.*, 1953).

For Pt I, see Abstr. 2358 (1954). A detailed experimental study of the forced convection constant. It is shown that the value of this constant is $7{\cdot}56 \times 10^{-5}$, the heat being measured in calories, and that it depends on the physical properties of the fluid. This value is in fair agreement with the theoretical value obtained from Nusselt's equation. The slight deviation from the theoretical value has been accounted for by considering the variation with temperature of the quantities involved in Nusselt's equation. A.

536.24 : 536.33

5530. Application of the similarity theory on radiation in furnaces. C.-H. YHLAND. *Chalmers Tekn. Högsk. Handl.*, *No.* 135, 31 *pp.* (1953).

The radiant heat transfer in furnaces is investigated with respect to the simple similarity theory. The dimensionless quantities are deduced from the general equation of equilibrium with the energy equation in a form containing the interaction of the radiative energy. An example of plotting experimental values in terms of the dimensionless quantities is given. The number of experiments available, however, is insufficient to allow any definite conclusion. A.

536.253

5531. The relation between the heat transfer and the convection phenomena in enclosed plane air layers. J. G. A. DE GRAAF AND E. F. M. VAN DER HELD. *Appl. sci. Res. A*, **4**, *No.* 3, 393–409 (1953).

A description is given of a systematic investigation of the heat transfer and the convection phenomena in enclosed plane air layers in horizontal, vertical, and oblique positions. Formulae for the heat transfer are given. Some interesting types of convection flow patterns are described and the influence they have upon the heat transfer is deduced from the measurements. A.

536.3 : 551.521

Energy transfer by infrared bands. *See Abstr.* 6167

536.413 : 535.55

5532. Stress-optical determination of thermal expansion coefficients of glasses. H. SCHWIEGER AND H. FIEDLER. *Ann. Phys.* [*Leipzig*] **14**, *No.* 1–2, 64–86 (1954) *In German.*

Two methods which enable thermal expansion coefficients, elastic moduli, and stress-optic constants of glasses to be found are presented. The theory and full experimental details are given. Glass rods are heated in a suitable apparatus, which is fully described, so that their expansion is restricted by known amounts. The resulting stress gives rise to artificial double-refraction which is a measure of the expansion coefficient and is determined by a quarter-wave plate compensator. Results for several glasses are given in the range 25 to 100°C. H. G. JERRARD

536.413 : 548

Thermal expansion of copper sulphate. *See Abstr.* 6108

536.421

5533. Melting temperatures of tin and lead at pressures reaching 34 000 kg/cm². V. P. BUTUZOV AND M. G. GONIKBERG. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 5, 1083–4 (1953) *In Russian.* English translation *U.S. National Sci. Found. NSF-tr*-144.

The melting temperatures (T_M) are reproducible within 3% with an apparatus previously described [Abstr. 8358 (1953)]. The average dT_M/dP [unit 10^{-3}°C cm²/kg] is 2·9 for Sn and 6·8 for Pb. dT_M/dP decreases slightly with increasing pressure. T_M for Pb is 532°C and for Sn 317°C at 34 000 kg/cm². F. ANSBACHER

536.421

5534. The dependence of the melting point on the pressure. J. SKOTNICKÝ. *Czech. J. Phys.*, **3**, 225–31 (*Sept.*, 1953).

Distinguishes between methods of applying external pressure to the individual components of a system. For the case of an isolated action of pressure on only one component there is derived a modified Clapeyron equation which is applied to other cases. A.

536.421.4

5535. Probability of formation of ice nuclei in supercooled water. L. G. KACHURIN. *Dokl. Akad. Nauk SSSR*, **93**, *No.* 2, 307–10 (1953) *In Russian.*

Since a drop of supercooled water freezes through formation and growth of a single crystal (L. G. Kachurin, 1951), measurements of the probability of freezing of such drops also give the probability of formation of ice nuclei. Such measurements are evaluated to give the value of C, the characteristic constant, as 20·1 and σ, the surface energy at the phase boundary, as 5·6 ergs/cm in the equation $w = \exp[C - (u/kT) - (4\pi\sigma/3kT)(2\sigma\mu/N\rho L \ln T_0/T)]$, where w = probability of formation of a crystal in 1 ml, per sec, T_0 = temp. of stable equilibrium between liquid and solid phase, u = energy of activation of molecules in the liquid state, μ = molecular weight, L = latent heat of fusion, k = Boltzmann const., and ρ = density of solid. R. C. MURRAY

536.421.4 : 551.574.1

Homogeneous nucleation of supercooled water drops. *See Abstr.* 6173

536.423

5536. An optical method for studying the region of precritical states of liquids. I. W. ŚWIETOSŁAWSKI AND T. GUTHNER. *Bull. internat. Acad. Polon. Sci. A*, *No.* 3–6, 69–73 (*March–June*, 1951).

By photographing a tube in transmitted light it is found that the appearance of the boundary is gradually modified in passing through the critical temperature. G. F. LOTHIAN

536.423

5537. Contribution to the study of the precritical region of liquids. II. W. Swietosławski, T. Gruzerski and S. Wollosiecki. *Bull. internat. Acad. Polon. Sci. A, No.* 3–6, 193–7 (*March–June*, 1951).

Photographs of the boundary taken under "optimum" conditions reveal several stages after the disappearance of the meniscus. G. F. LOTHIAN

536.423

5538. On the application of microphotometry to the studies of the phenomena in the precritical region of liquids. III. W. Swietosławski and H. Markowska. *Bull. internat. Acad. Polon. Sci. A, No.* 3–6, 75–9 (*March–June*, 1951).

Microphotometry of photographs of the boundary region can detect temperature changes of 0·1°C and changes of the boundary can be detected at higher temperatures than by normal observation.

G. F. LOTHIAN

536.423.1

5539. Variational formulas in evaporation theory. J. Greenstadt. *Phys. Rev.*, **93**, 1140–8 (*March* 15, 1954).

The Laplace transformation is first applied to the linearized one-dimensional Boltzmann equation to enable some remarks on the spectrum of the problem to be made. The original (linearized) equation is then brought into the form of a Fredholm equation, following K. Schwarzschild. A Schwinger variational function is then established for the distribution of molecules returning after being "sprayed" into a gas. Using these results, an integral equation is derived for the probability distribution of molecules at a liquid-vapour interface during slow (steady or time-dependent) evaporation. Finally, this theory is compared with elementary evaporation theory. A.

536.423.1

5540. Growth of a vapor bubble in a superheated liquid. H. K. Forster and N. Zuber. *J. appl. Phys.*, **25**, 474–8 (*April*, 1954).

The integro-differential equation for the growth of a vapour bubble in a superheated liquid is formulated and discussed. It is shown that two distinct time domains exist: one, of the order of 10^{-4} sec, during which the effect of the hydrodynamic forces may be an important factor in the growth of the bubble, and another, during which this effect is unimportant. An integral equation is formulated for the latter domain. A solution of the problem, in closed form, valid for the entire interval of interest is presented; it agrees very well with experimental data for various superheats. A.

536.423.1

5541. The growth of vapor bubbles in superheated liquids. M. S. Plesset and S. A. Zwick. *J. appl. Phys.*, **25**, 493–500 (*April*, 1954).

The growth of a vapour bubble in a superheated liquid is controlled by three factors: the inertia of the liquid, the surface tension and the vapour pressure. As the bubble grows, evaporation takes place at the bubble boundary, and the temperature and vapour pressure in the bubble are thereby decreased. The heat inflow requirement of evaporation, however, depends on the rate of bubble growth, so that the dynamic problem is linked with a heat diffusion problem. Since the heat diffusion problem has been solved, a quantitative formulation of the dynamic problem can be given. A solution for the radius of the vapour bubble as a function of time is obtained which is valid for sufficiently large radius. This asymptotic solution covers the range of physical interest since the radius at which it becomes valid is near the lower limit of experimental observation. It shows the strong effect of heat diffusion on the rate of bubble growth. Comparison of the predicted radius-time behaviour is made with experimental observations in superheated water and very good agreement is found. A.

536.423.4

5542. A generalization of Yang and Lee's theory of condensation. L. Witten. *Phys. Rev.*, **93**, 1131–5 (*March* 15, 1954).

Yang and Lee's theory of phase transitions is extended to include a wider class of potential energy functions. In particular, it is shown that the theory does not require a potential with a hard core; the repulsive part of the potential need only be greater than $1/r^n$; $n \geqslant 11 \cdot 4$. A.

536.424

5543. On some improvements on a cryoscopic precision-apparatus and on the control of a thermocouple. L. Cavallaro, A. Indelli and G. Pancaldi. *Ricerca sci.*, **23**, 2237–43 (*Dec.*, 1953) *In Italian.*

A description of the improvements on a precision apparatus for cryoscopy, consisting essentially in the substitution of the existing spiral agitating device with an air pressure pump. The conductometric method for concentration measurement is described, as well as the method for the calibration of the thermocouple, as based on the determination of fixed thermometric points and temperature points of known cryoscopic equilibria. Results obtained in the measurement of cryoscopic lowerings of aqueous KCl solutions are given. A.

536.424 : 532.78

5544. On the crystallization of vitreous selenium. S. Yamamoto and T. Yoshioka. *Sci. Rep. Tôhoku Univ. First Ser.*, **35**, 131–6 (*Dec.*, 1951).

The transformation from vitreous to metallic state is affected by many factors. The crystallization temperatures of vitreous selenium were measured by means of evolution of transformation heat. It is clarified that the temperature and the velocity of crystallization are greatly influenced by not only heating velocity but also purity of selenium used. A.

536.424 : 532.78

5545. Crystallization and melting of selenium containing iodine. S. Yamamoto and T. Yoshioka. *Sci. Rep. Tôhoku Univ. First Ser.*, **36**, 151–65 (*Nov.*, 1952).

Vitreous selenium transforms into metallic by heating, and the transition point is greatly affected by impurities contained in selenium. Iodine was added as an impurity and the transition points of selenium samples containing from 0·03 to 0·4% iodine were measured and the effect of iodine content on the transformation of selenium was investigated. The

present study shows that the crystallization or premelting (Vorschmelzung) of selenium begins at a much lower temperature, as the iodine contents are larger. A.

536.424 : 538.222

5546. A magnetic method for the determination of γ-loops in binary iron alloys and its application to the iron-silicon system. J. CRANGLE. *Brit. J. appl. Phys.*, **5**, 151–4 (*April*, 1954).

A new method of phase analysis which depends on measurements of paramagnetic susceptibility at different temperatures above the Curie point has been evolved. It is capable of indicating equilibrium conditions in two-phase alloys. The application to the iron–silicon system shows that here the γ-loop extends to a maximum of only 2·15% of silicon, and not 2·5% as previously reported. A.

536.44

5547. Critical temperatures of normal paraffins. Y. P. VARSHNI AND S. N. SRIVASTAVA. Letter in *J. chem. Phys.*, **22**, 349 (*Feb.*, 1954).

The values of the critical temperatures for 19 normal paraffins calculated from $T = 644{\cdot}5 \log (n + 2) - 75$ where n is the number of carbon atoms are tabulated and compared with the observed values. The difference for methane is large. S. WEINTROUB

536.44

5548. Critical temperature and boiling point of normal paraffins. S. S. MITRA. Letter in *J. chem. Phys.*, **22**, 156 (*Jan.*, 1954).

The function $S = n(T_c - T_b)/10$, where n is the number of C atoms in a normal paraffin hydrocarbon with critical temperature T_c and boiling point T_b (°K), is additive for the homologous series, the observed data agreeing fairly with the straight line $S = 18{\cdot}01n - 8{\cdot}81$. F. LACHMAN

536.44

5549. Critical temperature and pressure of *n*-paraffins. L. GRUNBERG. Letter in *J. chem. Phys.*, **22**, 157 (*Jan.*, 1954).

Discusses the recent publication of Varshni [Abstr. 8363 (1953)] in connection with a previous observation by the author and Nissan [*Nature*, **161**, 170 (1948)]. It is pointed out that, because of the approximate constancy of T_c/MP_c and the additivity of T_c^3, the function $(MP_c)^3$ is approximately additive.

F. LACHMAN

536.44 : 533.75

5550. PVT measurements in the critical region of xenon. H. W. HABGOOD AND W. G. SCHNEIDER. *Canad. J. Chem.*, **32**, 98–112 (*Feb.*, 1954).

Extensive PVT measurements of xenon extending from 1·8° above the critical temperature to the critical temperature, and in a few cases to 4° below the critical temperature, have been carried out at densities ranging from somewhat above the critical density to well below. In order to make the corrections for hydrostatic head small and easily calculable, a bomb having a height of only 1·0 cm was used in the present measurements. The previously reported value for the critical temperature 16·590° is confirmed. The critical density is estimated to be 1·099 ± 0·002 g/ml compared with 1·105 g/ml found previously. The critical pressure is found to 57·636 ± 0·005 atm. The isotherms at temperatur above the temperatures of meniscus disappearance not appear to have any flat portions. However, t critical isotherm is considerably flatter and broad over a range of densities than that corresponding a van der Waals equation, and at the critical poi the third and fourth derivatives of pressure wi respect to volume appear to be zero.

536.44 : 533.

5551. Thermodynamic properties of xenon in t critical region. H. W. HABGOOD AND W. C SCHNEIDER. *Canad. J. Chem.*, **32**, 164–73 (*Feb.*, 1954

Using the detailed compressibility data in t critical region of xenon given in the preceding pape supplemented by measurements of Beattie *et a* [Abstr. 118–19 (1952)] over a wider range of tempera tures and densities, thermodynamic properties hav been calculated for the critical region—extendi from the critical temperature to 50° above it and fro low densities to somewhat above the critical densit The values of C_v at the critical density are in goo agreement with those calculated from acoustical dat at temperatures higher than $T_c + 1°$; closer to th critical temperature, however, the C_v values derive from the equation of state data become much greate than those derived from the acoustic data. Thi difference can be accounted for by dispersion effect in the high-frequency acoustic data near the critica point. A

536.44

5552. Schlieren studies of the critical region. H. B PALMER. *J. chem. Phys.*, **22**, 625–34 (*April*, 1954).

The critical regions of ethane, carbon dioxide and xenon have been studied, using a schlieren optical system. The material to be studied was confined in a thermostatted high pressure cell having optically fla windows, and placed in the test section of the optica system. At temperatures over a range of about two degrees, in the critical region, refractive index gradients within the cell were determined as a function of height along the cell. From these data were calculated the density distribution, the pressure distribution and the shapes of the pressure-volume isotherms at the various temperatures. The technique permitted detailed study of the isotherms over a narrow range of pressures, too small to be observed by usual experimental methods. Extensive visual observations were made throughout the course of the experiments. Particular attention was devoted to the question of the equilibrium state in the critical region and the process of equilibrium attainment. A.

536.46

5553. Theory of linear flame propagation. II. Structure of the steady state. D. LAYZER. *J. chem. Phys.*, **22**, 229–32 (*Feb.*, 1954).

For Pt I, see Abstr. 4468 (1954). A quantitative approximate theory of flame structure in the steady state, including formulae for the determination of flame speeds, is set forth. The theory predicts that in a first approximation, the sensitivity of a steady deflagration wave to external perturbations depends upon the shape of the temperature profile, but not

ɔon the speed or width of the wave, or the pressure. is shown that the sensitivity increases with increasing ilution of the explosive mixture, in agreement with ıe explanation of inflammability limits suggested in t I. A.

536.461

5554. Composition profiles in pre-mixed laminar ames. R. PRESCOTT, R. L. HUDSON, S. N. FONER ND W. H. AVERY. Letter in *J. chem. Phys.*, **22**, 45–6 (*Jan.*, 1954).

The composition of the burning gas at various oints through premixed propane/air flames has been tudied by withdrawing samples through very fine quartz probes, quenching them by rapid expansion, nd analysing them in a rapid-scanning mass-spectroneter. So far the presence of N_2, A, O_2, C_3H_8, C_2H_4, C_2H_2, CO_2, CO, H_2O and H_2 has been detected. R. C. MURRAY

536.461

5555. Flat flames of ammonia in air. N. W. LUFT AND L. COHEN. Letter in *J. chem. Phys.*, **22**, 348 (*Feb.*, 1954).

Preheating of mixtures to 150°C enables flat flames nd polyhedral flames to be maintained. For 19·4% NH_3 with air the burning velocity is 21·3 cm/sec and ncreases slightly with excess air. Reaction chains involving OH and NH_2 are proposed. Temperature measurements and analyses of products have been made. A. G. GAYDON

536.48

5556. The liquid helium plant of the physical laboratory of the University of Louvain. A. VAN ITTERBEEK, L. DE GREVE AND H. MYNCKE. *Appl. sci. Res. A*, **3**, *No.* 6, 429–32 (1953).

A description is given of the "Collins" liquid helium plant, used as a closed cycle for the helium gas, as it has been installed at the University of Louvain since 1951. A.

536.48 : 536.632

5557. Specific heat of He^3 between 1·3°K and 2·3°K. G. DE VRIES AND J. G. DAUNT. Letter in *Phys. Rev.*, **92**, 1572–3 (*Dec.* 15, 1953).

Calorimetric investigation of liquid He^3 in a 96% mixture with He^4. Numerous measurements of the specific heat are made and results are plotted against the temperature. Observations scatter appreciably; authors estimate an error of ±10%. The accuracy of the result may be affected by a relatively large correction accounting for evaporation. Nevertheless a consistent interpretation of the results can be given. Authors are satisfied that the specific heat curve is not of the type of a Fermi gas. They suggest a formula consisting of a Fermi term and a Debye term (proportional to T^3) accounting for the contribution of longitudinal waves. Authors notice that the formula must not be used for extrapolation to lower temperatures since it does not account for the entropy of nuclear orientation. R. EISENSCHITZ

536.48 : 536.632

5558. The specific heat of liquid He^3. T. R. ROBERTS AND S. G. SYDORIAK. Letter in *Phys. Rev.*, **93**, 1418 (*March* 15, 1954).

Specific heat is deduced from the observed rate of temperature rise and the flux of heat into a spherical container. The amount of liquid helium in the container was varied systematically. The flux of heat was calculated from the leakage or, at higher temperatures, supplied by electric heating. It was found that the specific heat rises steadily from 0·83 cal/mole deg. at 0·540°K to 1·54 at 1·695°K. By calculating the entropy, the authors arrive at the conclusion that alignment of nuclear spins begins near 0·5°K. R. EISENSCHITZ

536.48

5559. Liquid helium films. K. R. ATKINS. Letter in *Phys. Rev.*, **92**, 1571–2 (*Dec.* 15, 1953).

A helium film on a vertical surface may be assumed to stand under a hydrostatic pressure which arises from the potential energies of gravitation and multilayer adsorption. From this assumption a relation between the height and the thickness of the film has been derived. To this relation the author adds a correction term which is due to the zero-point energy of longitudinal waves (modes of vibration) in the film. R. EISENSCHITZ

536.48

5560. "Closed" fountain effect in liquid helium II. C. A. REYNOLDS. Letter in *Phys. Rev.*, **93**, 1118 (*March* 1, 1954).

In a glass cylinder porous powder is packed between the bottom and a glass filter plate; a heating coil is fitted further upward; the cylinder is joined at the top to a narrow vertical glass tube. Apparatus is filled with helium II to such an extent that a shift of the meniscus shows any changes of volume. If electric power is supplied to the coil, the liquid contracts in accordance with the negative sign of the expansion-coefficient. At an increased supply of power, however, a marked expansion takes place which increases with increasing supply of power until the tube is heated to the λ-point. Subsequent reduction in power supply results in contraction with hysteresis. Observations are interpreted in terms of the thermomechanical effect. The author says that the thermomechanical upward force is partly counteracted by a downward force which is proportional to the relative increase in volume. R. EISENSCHITZ

536.48

5561. The nature of higher-order phase transitions with application to liquid helium. O. K. RICE. *Phys. Rev.*, **93**, 1161–8 (*March* 15, 1954).

A general discussion of the relation between transitions of various order, especially those which are not concerned with solid lattices. It is shown that third-order transitions bear much the same relation to anomalous first-order transitions as second-order transitions bear to ordinary first-order transitions. The conditions under which higher-order transitions can occur are considered, and it is shown that they may be associated with a dispersed phase. If the transition is second-order, the dispersed phase must undergo a transition in itself. The ideas concerning second-order transitions are applied to the λ transition in liquid helium. An argument is given, based on energetic grounds, which indicates that the superfluid in liquid helium is in the form of clusters which are separated in ordinary space as well as in momentum space. If this view is correct, the λ transition corresponds to the appearance of much larger clusters,

essentially marking the beginning of long-range orders. It is shown that the Bose–Einstein statistics is quite essential for the formation of the clusters; they cannot appear in He^3, and no λ transition is to be expected in He^3. Finally, a possible explanation is given for Taconis' hypothesis that He^3 is not soluble in the superfluid part of He^4. A.

536.48

5562. Note on the self-energy of single roton states in quantum hydrodynamics. F. A. KAEMPFFER. *Canad. J. Phys.*, **32**, 264–6 (*March*, 1954).

Ziman has shown that a quantization of the hydrodynamical equations together with a Debye-like cut-off for k yields Landau's expression, $E = \Delta + p^2/2\mu$, for the energy of single roton states. This procedure neglects phonon-roton interaction terms. When these are included as a perturbation it is found that $E = \Delta' + p^2/2\mu'$ in the second order where, for He, $\mu' \doteqdot \mu$ and $\Delta' \doteqdot -2\Delta$. It is concluded that the phonon-roton interaction cannot be considered as small in the sense of perturbation theory. R. O. DAVIES

536.532

5563. Inhomogeneity e.m.f.s in thermoelectric thermometers. N FUSCHILLO. *J. sci. Instrum.*, **31**, 133–6 (*April*, 1954).

A criticism is made of the methods available for selecting metallic wires to be used in the construction of thermoelectric thermometers. Methods are described which increase the reliability, rapidity and convenience of selection tests. Techniques are introduced for the construction of more homogeneous thermocouples and multijunction thermoelements from a test cable of the wire under consideration, thus extending the range of application of the thermoelement to the precise measurement of larger temperature differences and the validity of its calibrations to more varied conditions. Examples are given of the application of these procedures to the construction of low temperature copper/constantan thermometers. A.

536.532 : 621.317.39

5564. Measurement of temperature by thermocouple and galvanometer. L. G. A. SIMS. *Engineering* [*London*] **177**, 180–1 (*Feb.* 5, 1954).

Precision measurements of very small temperature changes involving microvolts are considered with relation to the galvanometer characteristics, particularly periodic time as modified by the damping from a shunt and the thermocouple, which normally provide overdamping. A method of determining the overdamping correction is given, with experimental results in support. E. H. W. BANNER (R)

536.62

5565. Two new forms of melting point calorimeters for determining the purity of liquids of condensed gases. J. T. CLARKE, H. L. JOHNSTON AND W. DE SORBO. *Analyt. Chem.*, **25**, 1156–9 (*Aug.*, 1953).

536.631

5566. Hydrogen peroxide: the low temperature heat capacity of the solid and the third law entropy. P. A. GIGUÈRE, I. D. LIU, J. S. DUGDALE AND J. A. MORRISON. *Canad. J. Chem.*, **32**, 117–28 (*Feb.*, 1954).

The heat capacity of crystalline hydrogen peroxide between 12°K and the melting point has been det mined with a low-temperature adiabatic calorimet The heat of fusion was also measured and found to 2987 ± 3 cal/mole. The two samples of hydrog peroxide used were 99·97 mole % pure as deduced fr behaviour on melting and from premelting he capacities; the triple point was estimated to 272·74°K. The only anomaly observed in the he capacity measurements was the absorption 1·3 cal/mole at 216·8 ± 0·15°K, the lower eutec temperature of H_2O–H_2O_2 solutions. Such an effe is to be expected if the only significant impurity water. The entropy of hydrogen peroxide as an ide gas at 1 atm. pressure and 25°C computed from t thermal measurements is 55·76 ± 0·12 cal/mole de Comparison of this datum with the recalculat statistical entropy leads to a value of 3·5 kcal/mo for the height of a hypothetical single barrier hinde ing internal rotation in the molecule. From the results it is concluded that hydrogen peroxide do not consist of two tautomeric modifications.

536.6

5567. Latent heat of sublimation of fifteen salts fro spectroscopic and thermochemical data. M. S. SODH AND Y. P. VARSHNI. *Indian J. Phys.*, **27**, 520–2 (*Oc* 1953).

The latent heats of sublimation of fifteen salt which have not been experimentally determined, a calculated from spectroscopic and thermochemica data. A

536.658.

5568. The effect of hysteresis on the heat of wettin of partially saturated cellulose in water and its bearin on the physical structure of cellulose. M. WAHBA AN S. NASHED. *Proc. Egypt. Acad. Sci.*, **8**, *No.* 1, 128–3 (1952, publ. 1953).

Adsorption and desorption isotherms of wate vapour on standard cellulose were determined a 20°C. The heat of wetting W of dry and partiall saturated cellulose were measured also at 20°C, th moisture content C being obtained either by adsorp tion on dried samples (W_{ads}) or by partial desorptio from vapour-saturated samples (W_{des}). At equa humidities W_{ads} was more than W_{des} all the wa through. With equal moisture contents W_{des} wa less than W_{ads} at low values of C; but the situatio was reversed when C was more than 0·015. Sorptio hysteresis is interpreted in terms of a difference in the availability of the adsorbing surface in the amorphous regions of the cellulose structure when the humidity is increased or decreased. The heat of wetting results are discussed in accordance with the theory of hysteresis. A.

THERMODYNAMICS 536.7/.8

536.7

5569. Thermodynamical functions of propene at temperatures between 25°C and 150°C and at pressures up to 2500 atm. A. MICHELS, T. WASSENAAR, P. LOUWERSE, R. J. LUNBECK AND G. J. WOLKERS. *Appl. sci. Res. A*, **4**, *No.* 1, 34–8 (1953).

536.7

5570. Isotherms of air between 0°C and 75°C and pressures up to 2200 atm. A. MICHELS, T. WASSENAAR AND W. VAN SEVENTER. *Appl. sci. Res. A*, **4**, *No.* 1, 52–6 (1953).

536.7

5571. Isotherms and thermodynamical functions of two mixtures containing ammonia between 75°C and −50°C and at pressures up to 300 atm. A. MICHELS, T. WASSENAAR, G. J. WOLKERS, W. VAN SEVENTER AND A. J. VENTEVILLE. *Appl. sci. Res. A*, **4**, *No.* 3, 180–8 (1954).

Compressibility isotherms of two gas mixtures were measured. The compositions were respectively H_2–N_2–NH_3 = 58·6 — 19·6 — 21·8 (mol.%) and H_2–N_2–NH_3–A–CH_4 = 52·7 — 17·6 — 19·8 — 4·0 — 5·9 (mol.%). Thermodynamical functions have been calculated as a function of temperature and pressure. A.

536.7

5572. Isotherms of xenon at temperatures between 0°C and 150°C and at densities up to 515 amagats (pressures up to 2800 atmospheres). A. MICHELS, T. WASSENAAR AND P. LOUWERSE. *Physica*, **20**, 99–106 (*Feb.*, 1954).

536.7

5573. A new examination of the laws of thermodynamics. R. B. GREEN. *Amer. J. Phys.*, **22**, 191–3 (*April*, 1954).

The first law is stated in a new, simpler form which is qualitative, and its quantitative content is proved as a corollary. This is done for both the Poincaré and the Carathéodory methods. A statement of the second law is given. Minimum requirements for statements of the laws are discussed, and new alternative statements suggested. A.

536.7 : 539.133

5574. Statistical thermodynamics of a one-dimensional polymer chain incorporating energy and entropy effects. K. W. SCOTT AND A. V. TOBOLSKY. *J. Colloid Sci.*, **8**, 465–73 (*Aug.*, 1953).

In the model set up the segments of the chain are of equal length and point in either the positive or negative direction. Successive segments when pointing in opposite directions constitute an interaction of energy ε, the zero point of energy being assigned to the straight or extended form of the chain. When ε is negative the folded form, when ε is positive the extended form is preferred. The number of possible chain configurations is obtained statistically and the equation of state, heat capacity, mean square of the end-to-end dimensions and of the free rotation length derived. Mathematical details are given in an appendix. W. GOOD

536.71

5575. Generalized Fermi–Thomas theory. M. K. BRACHMAN. Letter in *Phys. Rev.*, **93**, 636 (*Feb.* 1, 1954).

See Abstr. 4744 (1949). A simplification of the operations is outlined, based on the author's previous work [Abstr. 1749 (1952)].

536.76

5576. Thermodynamics of systems of any number of components. B. N. SRIVASTAVA AND R. P. RASTOGI. *Proc. Nat. Inst. Sci. India*, **19**, 613–22 (*Sept.–Oct.*, 1953).

A generalized thermodynamic theory of multicomponent systems based on Gibbs's method has been developed and the general conditions of equilibrium for a mixture of chemically non-interacting constituents existing in both the condensed and vapour phases worked out. The temperature, pressure and mole-fractions of the various components have all been allowed to vary simultaneously and a general equation connecting all these variations obtained for any solution of non-electrolytes, giving the modified Clausius-Clapeyron relation. From this equation various important formulae for particular cases have been deduced, all of which are capable of experimental verification. For ideal mixtures the relations become particularly simple and readily yield the well-known laws of changes in temperature and pressure with concentration. A.

536.76

5577. Experimental tests of the modified Clausius–Clapeyron relation for ideal multi-component mixtures. B. N. SRIVASTAVA AND R. P. RASTOGI. *Proc. Nat. Inst. Sci. India*, **19**, 653–64 (*Sept.–Oct.*, 1953).

The modified Clausius–Clapeyron relation deduced in the preceding abstract for the thermodynamic equilibrium of a system of any number of components existing in the vapour and condensed phases has been applied to several ideal liquid mixtures. The relations deduced there between pressure, temperature and concentrations and their variations have been shown to be accurately obeyed by the binary mixtures ether-benzene, toluene-carbon tetrachloride and benzene-toluene. Various particular cases have also been tested. For the ternary system carbon tetrachloride-toluene-ethylene dibromide also, these formulae have been found to hold equally well and the effects of the variation of concentrations of the various components are quantitatively discussed and shown to agree with theoretically predicted values. A.

536.77

5578. Adiabatic transformations of finite amplitude. P. G. BORDONI. *Ricerca sci.*, **23**, 1569–78 (*Sept.*, 1953).

Temperature changes due to adiabatic transformations of finite amplitude are evaluated by means of a thermodynamic potential. It is shown that finite adiabatic transformations can be realized in which temperature does not vary, and some problems of adiabatic elasticity are treated. The results give a new and satisfying evidence of the soundness of the fundamental hypotheses from which the potential was obtained. A.

536.8

5579. Note on the efficiency of thermal machines at a finite rate of expansion. L. J. F. BROER. *Appl. sci. Res. A*, **4**, *No.* 1, 1–10 (1953).

By using the methods of gas dynamics the work done during expansion of an infinite mass of gas at finite speed is calculated. For the case that this speed

is small compared with the speed of sound it is verified by an explicit calculation that this process will raise the entropy of the gas by the amount required by thermodynamics. In the last section some remarks on the expansion of a finite mass of gas are made. A.

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.122

5580. On a finite difference equation for the classical electron. F. Duimio. Letter in *Nuovo Cimento*, **11**, 326–9 (*March*, 1954) *In Italian.*

Equations of motion are derived from a modified Fokker variation principle involving a shift of origin of the δ-function, mass being assumed to be of electromagnetic origin. The resulting equations are shown to be equivalent to finite difference equations which are related to those proposed by Caldirola [Abstr. 4735 (1954)]. R. A. NEWING

ELECTROSTATICS . DIELECTRICS 537.2

537.226

5581. Polarization of dielectrics by slow particles. II. On the initial conditions in Fourier expansions. H. Peltzer. *Rep. Brit. Elect. Res. Assoc., Ref. L/T*280, 8 *pp*, (1952).

First a résumé, illustrated by a simple example, is given of some known methods of fulfilling initial conditions in Fourier expansions. These are then applied to confirm a result and complete a solution of the previous report [Abstr. 1894 (1949)]. A.

537.226

5582. A mathematical extrapolation method for complex dielectric polarisation data. P. T. Narasimhan. *J. Indian Inst. Sci. A*, **35**, 113–21 (*April*, 1953).

A mathematical extrapolation method is outlined and applied to complex dielectric polarization data on dilute solutions of a polar molecule in a non-polar solvent. It is shown that accurate values of both the dipole moment and relaxation time of molecules may be obtained from measurements employing even one frequency alone very near the absorption region. A.

537.226

5583. On the absorption maxima exhibited by some organic liquids in the microwave region. I. D. K. Ghosh. *Indian J. Phys.*, **27**, 511–19 (*Oct.*, 1953).

The absorption of 3·18 cm microwaves in chloroform, ethylene chloride, ethylene bromide and glycerine at different temperatures was studied by the direct method, avoiding formation of standing waves. A maximum in the absorption-temperature curve was exhibited by each of the four liquids. The temperatures for maximum absorption are −45°C, −10°C, 21°C and 100°C for chloroform, ethylene chloride, ethylene bromide and glycerine respectively. It is pointed out that the values of λ_m, the wavelength corresponding to the maxim absorption calculated by previous workers from Cole and Cole empirical relation on the assumpti of the existence of a distribution of relaxation ti do not agree with the values observed by the dir method in the present investigation. It is furth pointed out that actually different discrete values the relaxation time, more than one in number, a present in most of the liquids, instead of a continuo distribution of relaxation time assumed in Cole a Cole empirical relation. The radius of the rot calculated from Debye's equation comes out to be t low in all the four cases and the reasons for th discrepancy have been discussed.

537.226.1.

5584. A method of measuring the dielectric consta of isotropic powders. J. A. Reynolds. Letter *Proc. Phys. Soc.* [*London*] *B*, **67**, 267–9 (*March*, 1954

Measurements show that the permittivity ε of dispersion of isotropic particles of permittivity ε_1 in medium of permittivity ε_2 varies linearly with th volume fraction δ_1 of the particles, provide $\varepsilon_1 - \varepsilon_2 < 0{\cdot}1$. Extrapolation to $\delta_1 = 1$ gives $\varepsilon = \varepsilon$ J. H. MASO

537.226.1.08 : 621.317.331 : 621.317.335

5585. Theory of measurement of dielectric consta and conductivity of the soil at ultra-high frequencies. S. S. Banerjee and P. C. Banerjee. *J. sci. indust Res.*, **12B**, 335–41 (*Aug.*, 1953).

A mathematical equation has been developed fo the relation between the field strength at any give distance from the transmitter and the soil constant of the region, both for vertically and horizontall polarized waves. Comparing the theoretical curve between field strength and distance with thos obtained by practical observations, the values of th conductivity and permittivity of the soil wer computed. A

537.226.2 : 539.13

5586. Studies in the dielectric constants of fatty acids. R. S. Phadke.

I. A comparative study of the equations of Onsage and of Jatkar in relation to experimental data on pur liquids. *J. Indian Inst. Sci. A*, **34**, 189–207 (*July*, 1952).

II. Correlation between the structure and the dielectric constant of fatty acids. *Ibid.*, **34**, 293–304 (*Oct.*, 1952).

III. The applicability of Jatkar's equation to concentrated solutions of esters of fatty acids. *Ibid.*, **35**, 31–37 (*Jan.*, 1953).

IV. Dipole moments of cis- and trans-forms of monocarboxylic acids. *Ibid.*, **35**, 123–9 (*April*, 1953).

537.226.2 : 541.183

5587. Dielectric properties of vapors adsorbed on silica gel. II. Dielectric dispersion of adsorbed water vapor. K. Kamiyoshi and T. Odake. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 271–7 (*June*, 1953).

For Pt I, see Abstr. 4453 (1953). The low-frequency dielectric dispersion of water vapour adsorbed on silica gel has been observed at various temperatures and in various adsorbed amounts. The relation between resonance frequency, temperature and adsorbed amount is obtained experimentally. It is

ncluded that the origin of the dispersion seems to e of Wagner type which is due to the heterogeneity conductivity of the substance including silica gel, r gap and adsorbed water film. A.

537.226.2 : 621.3.011.5 : 621.315.616.9

5588. Dielectric properties of Teflon from room temperature to 314°C and from frequencies of 10^2 to 10^5 c/s. P. EHRLICH. *J. Res. Nat. Bur. Stand.*, **51**, 85–8 (*Oct.*, 1953).

The permittivity and dissipation factor of Teflon were measured at frequencies from 10^2 to 10^5 c/s and from room temperature to temperatures just below the first-order transition point occurring at 327°C. Measurements of the d.c. conductivity were made over the same temperature interval. Results show that the permittivity decreases somewhat with increasing temperature. The relation between thermal-expansion coefficient and temperature coefficient of the permittivity is roughly as predicted by the Clausius–Mossotti equation. Values of dissipation factor and d.c. conductivity at all temperatures are very low ($<2\times10^{-4}$ and 2×10^{-15} mho/cm, respectively), and the dielectric constant is independent of frequency at all temperatures. A.

537.226.2 : 548.74

Ferroelectric structure of potassium dihydrogen phosphate. *See Abstr.* 6145–6

537.226.2

5589. Thermal pseudohysteresis of the dielectric constant of ferroelectric titanates. A. PIEKARA AND Z. PAJAK. *Acta phys. Polon.*, **11**, *No.* 3–4, 256–62 (1951–52).

Measurements of the dielectric constant of barium titanate and barium-strontium titanate were made in various temperatures with an alternating current of 2 and 5 kc/s frequency and a distinct anomaly in the dependence of the dielectric constant on temperature was discovered: the curve $\varepsilon = f(t)$ is different during the heating and the cooling of a sample. Values of the dielectric constant during cooling (above as well as below the Curie point) are higher than those measured at the same temperatures during heating. In the direct vicinity of the Curie point the value of the dielectric constant is higher by over 10% during cooling than the maximum value observed during heating. The authors have called this phenomenon the thermal pseudohysteresis of the dielectric constant because of the characteristic appearance of the residue after the former thermal state. A.

537.226.2

5590. Effect of electric field on the dielectric constant of ferroelectric titanates. A. PIEKARA AND Z. PAJAK. *Acta phys. Polon.*, **12**, *No.* 3–4, 170–80 (1953).

The dielectric constant of polycrystalline barium- and barium-strontium titanates was measured as a function of temperature, time, a.c.-measuring field and d.c.- and a.c.-biasing fields. In particular the relation between the dielectric constant and the d.c.-biasing field was investigated. Curves of the dielectric constant as a function of the d.c.-biasing field for quasistatic states both below and above the Curie point were obtained. The effect of prepolarization of the sample on the measured time changes of the dielectric constant below the Curie point was observed. This "prepolarization-effect" manifested itself in different values of the dielectric constant corresponding to different directions of the applied fields. A.

537.226.33 : 539.133

5591. On the relaxation time of polar molecules in the liquid state. S. C. SIRKAR. *Indian J. Phys.*, **27**, 475–82 (*Oct.*, 1953).

It is pointed out that the values of λ_m, deduced by previous workers from the Cole and Cole equation (1941) do not agree with the values actually observed by some recent workers in the case of a few polar liquids. Debye's theory is extended to the case of a liquid containing a mixture of monomeric and dimeric molecules and an expression for the complex dielectric constant has been deduced. It is found that the expression is too complicated to yield a simple condition for maximum absorption. The various causes for the discrepancy between the actual molecular volume and the volume of the rotor calculated from Debye's theory observed in certain cases are discussed. A.

537.228.4

5592. Electro-optical effect in $NH_4H_2PO_4$. P. MOKRÝ. Letter in *Czech. J. Phys.*, **2**, 145 (1953) *In Russian.*

Measurements were made of the modulus $f_{63} = (1/n_1^3)(dn_a/dE)$ from 150 to 300°K. The ratio $f_{63} : P_c$ (polarization) was found constant and equal to $3\cdot6\times10^{-7}$ (c.g.s.) and, at 296°K, $f_{6\cdot3} = 3\cdot0\times10^{-7}$ (c.g.s.). The effect is linear with electric field in the range ±13 kV/cm. Detailed results will be published later. W. BARDSLEY

537.24 : 541.182.2/.3

A new method for the measurement of aerosol electrification. *See Abstr.* 6089

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.31

5593. The extra-resistivity due to vacancies in copper, silver and gold. P. JONGENBURGER. *Appl. sci. Res. B*, **3**, *No.* 4–5, 237–48 (1953).

Lattice defects in metals, for instance, dislocations, interstitial atoms or vacancies, such as can arise from coldworking or neutron irradiation, cause an extra-resistivity. In this paper the resistivity due to vacancies is calculated for copper, silver and gold. The conduction electrons are supposed to be completely free. The scattering area of a vacancy in Cu is found from the field of this atom, for which were taken (*a*) the negative of the Hartree-field of Cu^+, (*b*) a suitably chosen rectangular field. The results of these calculations being about the same, the case of Ag and Au is treated, using a rectangular field only. It then turns out that for monovalent metals the extra-resistivity per per-cent vacancies is proportional to the atomic radius. The results for Cu, Ag and Au are, respectively, 1·3, 1·5 and 1·5 $\mu\Omega$.cm/% vacancies; which make it possible to calculate the

number of vacancies in certain cases. For Cu a vacancy has about the same influence on the resistivity as a dissolved Ni atom. A.

537.311.31 : 548.7

5594. Structural defects in copper and the electrical resistivity minimum. T. H. Blewitt, R. R. Coltman, Jr. and J. K. Redman. Letter in *Phys. Rev.*, **93**, 891 (*Feb.* 15, 1954).

From the observation that worked single crystals show a negative temperature coefficient below 4·2°K only after recrystallization by annealing at 1000°C, it is concluded that crystal boundaries have a trapping effect on the conduction electrons. H. London

537.311.32 : 541.135.4

5595. Ionic conductivity of impure polar crystals. A. B. Lidiard. *Phys. Rev.*, **94**, 29–37 (*April* 1, 1954).

Experimental determinations of the ionic conductivity of impure or "doped" alkali halide crystals are often used to find the mobility of the cation vacancies. For this purpose it is important to know to what extent the vacancies and the impurity ions have associated together to form neutral "complexes," which do not contribute to the conductivity. Previous interpretations of the experimental data have relied largely on the law of mass action to give the degree of association, but have neglected the long-range Coulomb interactions between the unassociated impurity ions and vacancies. The effect of these interactions on the calculated degree of association and upon the d.c. conductivity is examined in this paper. The interactions are shown to be significant even in systems containing impurities in concentrations of no more than one part in 10^4. A new analysis of the results obtained by Etzel and Maurer for the system $NaCl+CdCl_2$, leads to a binding energy of about 0·35 eV for the cadmium ion-vacancy complex. The mobility of the sodium ion vacancy is found to be about 30% larger, at all temperatures, than was inferred by Etzel and Maurer, using a simpler theory to interpret the data. The activation energy for the vacancy motion remains, however, at about 0·9 eV. A.

537.311.33

5596. A micromanipulator for electrical investigations of semiconducting materials. A. Kelen. *Appl. sci. Res. B*, **3**, *No.* 2, 125–8 (1953).

A micromanipulator is described that permits independent operation of one to five electrode points. The apparatus is easily constructed and requires little precision work. A.

537.311.33

5597. Interpretation of Hall effect and resistivity data in PbS and similar binary compound semiconductors. W. W. Scanlon. Letter in *Phys. Rev.*, **92**, 1573–5 (*Dec.* 15, 1953).

Presents curves of resistivity and Hall effect taken on a natural *n*-type PbS crystal for a series of temperature cycles between room temperature and maximum temperatures of 700, 800, 900 and 1000°K. There is evidence of composition changes and the irreversible character of the Hall effect curves is evident. It is suggested that recently published values of the energy gap in PbS, derived from the slope of Hall effect curves, are too large and due more to composition changes in the material than to intri behaviour. Results from Hall effect data up to c 500°K give $\Delta E = 0{\cdot}37$ eV, in good agreement v optical data. A. E. DE B.

537.31

5598. Further experimental investigations on s ferromagnetic oxidic compounds of manganese perovskite structure. J. Volger. *Physica*, **20**, 49 (*Feb.*, 1954).

Polycrystalline substances of the type $La_{1-\delta}Sr_\delta M$ were investigated. These are ferromagnetic s conductors which exhibit some remarkable sec order effects related to the electrical conductivity. specific heat has been found to be in agreement Weiss's theory. New data on the direct cu resistivity including that at liquid hydrogen perature have been obtained. The direct cu magneto-resistance appears to be independent c mutual orientation of magnetic field and cu most of the effect seems to be due to domain rota The alternating current resistivity of some sa depends strongly upon frequency and high valu the dielectric constant have been observed a frequencies. Samples exhibiting these properties show a magneto-resistance dependent on the freq of the alternating current, and a variation of resistivity and magneto-resistance with applied vo These effects strongly support the hypothes barrier-layer resistance in ceramic semicondu A phenomenological analysis of these effects is and may be of some importance for the g problem of magneto-resistance in ferromag The Seebeck effect of various samples is roug agreement with certain basic ideas on conduct oxidic semiconductors. From Hall effect m ments no conclusions could be drawn except t apparent electron mobility is extremely small also Abstr. 5947 (1950); 309 (1951).]

537

5599. Semiconducting compounds and the s electronegativities. C. H. L. Goodman. *Proc. Phys. Soc.* [*London*] *B*, **67**, 258–9 (*March*

The relationships between melting point, gap and electronegativity difference (ionic con of bonding) are examined for III–V and II–V pounds with the zinc blende structure. The p energy gap values and high electron mob several II–VI compounds (especially HgSe), that these may be suitable for use in semico devices. J

5

5600. A chemical approach to the trea electronic spin in semiconductors. J. H. Cr Jr and D. K. Holmes. Letter in *Proc. P* [*London*] *A*, **67**, 294–5 (*March*, 1954).

The equilibrium concentrations of non-d free electrons, and of ionized and unionize are determined from a dissociative eq equation. F. A

5

5601. Experimental evidence concerning d in germanium. E. M. Conwell. Letter in *H* **93**, 1118 (*March* 1, 1954).

Draws attention to the lack of agreemen

heory and experiment for germanium, particularly he variation of lattice mobility with temperature, the hift of the energy gap per unit dilatation, and the hange in energy gap per degree change in temperature.
A. E. DE BARR

537.311.33

602. Theory of the galvanomagnetic effects in -germanium. S. MEIBOOM AND B. ABELES. Letter in *hys. Rev.*, **93**, 1121 (*March* 1, 1954).

Calculation of the galvanomagnetic constants for -type Ge on the following assumptions: (1) the elaxation time is given by constant/√energy; (2) the nergy as a function of momentum has a number of inima, electrons near each of these minima contribute to the conductivity, and the energy surfaces, ear the minima, can be approximated by quadratic unctions of P. Good agreement is found with the xperimentally measured constants. A. E. DE BARR

537.311.33

603. Transmission of electrons and holes across a win boundary in germanium. E. BILLIG AND M. S. IDOUT. Letter in *Nature* [*London*] **173**, 496–7 (*March* 13, 1954).

Measurements of diffusion distance and transistor ction across a twinning plane in a Ge sample indicate o evidence of any discontinuity or potential gradient t the twinning plane or in its vicinity.
C. A. HOGARTH

537.311.33

604. Diffusivity and solubility of copper in germanium. C. S. FULLER, J. D. STRUTHERS, J. A. ITZENBERGER AND K. B. WOLFSTIRN. *Phys. Rev.*, **3**, 1182–9 (*March* 15, 1954).

The diffusivity and solubility of Cu in Ge have been vestigated as a function of temperature in the temerature range 700°–900°C, both by resistivity and dioactivity methods. The average diffusivity is $8 \pm 0{\cdot}3 \times 10^{-5}$ cm²/sec in this temperature interval. he solubility shows a maximum of $4{\cdot}0 \times 10^{16}$ atoms copper cm^{-3} at about 875°C. The precision is not fficient to determine an activation energy for mfusion. However, calculations based upon a theory In Wert and Zener, indicate an activation energy of out 4000 cal. The "thermal conversion" effect in co is explained by a temperature-dependent solution he precipitation of Cu. It is suggested that the eptor and diffusional properties of Cu in Ge can be accounted for by decreased electron affinity of Cu aft higher temperatures. A.

537.311.33

605. Drift mobilities in semiconductors. II. Silicon. M. B. PRINCE. *Phys. Rev.*, **93**, 1204–6 (*March* 15, 1954).

For Pt I, see Abstr. 2424 (1954). The drift mobility and holes in *n*-type silicon and electrons in *p*-type fu on has been measured as functions of impurity an centration and temperature. In single crystals of resistivity greater than 10 ohm-centimetre, the d.c bility at 300°K of holes is $\mu_P = 500 \pm 50$ cm²/volt-die and of electrons is $\mu_N = 1200 \pm 100$ cm²/volt-sec. fie this high-resistivity material, the temperature Cu endence of mobility in the same units is $\mu_N = 1{\cdot}0 \times 10^6 T^{-1{\cdot}5}$ and $\mu_P = 2{\cdot}4 \times 10^8 T^{-2{\cdot}3}$. A.

537.311.33

5606. Piezoresistance effect in germanium and silicon. C. S. SMITH. *Phys. Rev.*, **94**, 42–9 (*April* 1, 1954).

Uniaxial tension causes a change of resistivity in silicon and germanium of both *n* and *p* types. The complete tensor piezoresistance has been determined experimentally for these materials and expressed in terms of the pressure coefficient of resistivity and two simple shear coefficients. One of the shear coefficients for each of the materials is exceptionally large and cannot be explained in terms of previously known mechanisms. A possible microscopic mechanism proposed by C. Herring which could account for one large shear constant is discussed. This so-called electron transfer effect arises in the structure of the energy bands of these semiconductors, and piezoresistance may therefore give important direct experimental information about this structure. A.

537.311.33

5607. The electrical conductance of pressed powders, in particular of zinc oxide. J. C. M. BRENTANO AND C. GOLDBERG. *Phys. Rev.*, **94**, 56–60 (*April* 1, 1954).

The electrical conductance of a pressed semiconducting material in powder form, representing a multiboundary semiconductor, is investigated. Experiments are described in which the d.c. conductance of the powder pressed between parallel plates in an evacuated chamber is determined for different pressures and temperatures. A model based on the change of the energy gaps with pressure is developed which accounts for the phenomena observed. Transient changes of conductance with time are observed for which only tentative explanations are suggested. Most of the experimental work refers to zinc oxide.
A.

537.311.33 : 537.32

5608. Thermoelectric power of the non-polar semiconductor, that of tellurium crystals as an example. T. FUKUROI AND S. TANUMA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4**, 353–68 (*Aug.*, 1952).

To explain the experimental results on the thermoelectric power of the crystals of pure tellurium and those alloyed with less than 5% antimony, the thermoelectric power of the non-polar composite semiconductor in general has been derived. Numerical calculations carried out for tellurium crystals have shown that the measured characteristics can well be accounted for throughout the temperature range being studied. The quantitative discordance observed at higher temperatures has been explained by a more or less elaborated theory in which a dual band structure which consists of two overlapped energy bands is assumed for the conduction band, the same band scheme being compatible with other electric properties of tellurium. A.

537.311.33 : 537.32

5609. Electrical properties of α-Fe_2O_3. F. J. MORIN. *Phys. Rev.*, **93**, 1195–9 (*March* 15, 1954).

The conductivity, Seebeck effect and optical transmission of α-Fe_2O_3 have been analysed using two alternative models. The first model assumes conduction to occur in the *d* levels of Fe ions and yields a

quantitative fit to the data. Mobility behaviour determined with this model is explained in terms of wavy bands. The second model assumes conduction in the *sp* bands of oxygen in addition to *d*-level conduction. It is shown qualitatively to be a reasonable model. A.

537.311.33 : 537.32

5610. Electrical properties of NiO. F. J. MORIN. *Phys. Rev.*, **93**, 1199–204 (*March* 15, 1954).

The conductivity, Seebeck effect and optical transmission of NiO have been analysed using two alternative models. The first model assumes conduction to occur in the *d* levels of Ni ions and yields a quantitative fit to the data. Mobility behaviour determined with this model is explained in terms of wavy bands. The second model assumes conduction in the filled *sp* band of oxygen in addition to *d*-level conduction. It also yields a quantitative fit to the data which, however, is unsatisfactory because the concentrations and mobilities which result for *d* carriers appear unreasonable. Examples of grain boundary conduction are analysed. A.

537.311.33 : 537.533.8

5611. Researches on the activation energy of (Ba, Sr)O by electron bombardment. K. OHIRA. *Mem. Coll. Sci. Univ. Kyoto A*, **26**, 131–41 (*Oct.*, 1950).

When (Ba, Sr)O is bombarded by electrons, it is found that the resistance *v.* accelerating voltage curve shows a trough at a certain accelerating voltage. By the estimation of the kinetic energy of an incident electron which causes the trough change, it has been found that the optical activation energy required to remove an electron from the impurity level to the conduction band is about 3·35 eV. This agrees with the value as estimated roughly from thermionic data. By this method may be obtained the energetic structure of a substance that cannot be investigated by a spectroscopic method. To get more accuracy, however, the results obtained by this method must be compared with those obtained by the spectroscopic method for well-known substances. Moreover, it has been found that the impurity level plays an important role in the phenomenon of secondary emission of excess-type impurity semi-conductors. A.

537.311.33 : 548.7

5612. Radiation effects in indium antimonide. J. W. CLELAND AND J. H. CRAWFORD JR. Letter in *Phys. Rev.*, **93**, 894 (*Feb.* 15, 1954).

The conductivity of a low-resistivity *n*-type InSb sample decreases monotonically during irradiation in a reactor, the initial rate of electron removal (by trapping at bombardment-produced lattice defects) being about four times that for Ge. *p*-Type samples are converted to *n*-type due to transmutation of In to Sn. A. E. DE BARR

537.311.33

5613. On the electrical formation of the selenium rectifiers fumed with sulphur vapour. S. YAMAMOTO AND T. YOSHIOKA. *Sci. Rep. Tôhoku Univ. First Ser.*, **35**, 232–41 (*Jan.*, 1952).

In order to increase the effect of the electrical formation, the selenium rectifier disks are fumed with sulphur vapour of not very high purity. The d.c. characteristics and the capacities of the fu rectifier disks are measured before and after t electrical formations, and after heating also. T the thicknesses of the barrier layers and the dens of impurity centres are estimated.

537.311

5614. Heat treatment of the selenium rectifiers fu with sulphur vapour. S. YAMAMOTO AND T. YOSHIO *Sci. Rep. Tôhoku Univ. First Ser.*, **36**, 73–81 (*A* 1952).

The disks are subjected to heat treatment and t to electrical formations. Increase of the block voltage, decrease of effective capacity and increase decrease of effective resistance are noticed. thermal diffusion of sulphur or its impurity cau by heat treatment increases the blocking volta The electrical formation increases the blocking volta much more than the heat treatment. The increase the thickness of the barrier layer caused by h treatment is larger than that caused by electri formations, while the increase of effective resista caused by heat treatment, at bias voltages >2 V, less than that caused by electrical formations.

537.311

5615. Water vapor and the "channel" effect *n-p-n* junction transistors. R. H. KINGSTON. Let in *Phys. Rev.*, **93**, 346 (*Jan.* 15, 1954).

Experimental and theoretical work stimulated by paper of Brown [Abstr. 7669 (1953)]. The effect explained as being due to neutral impurities of don type, embedded in the surface, and whose densi increases with water vapour pressure. These neut impurities can be ionized by the application of electric field and thus form a surface conducti channel. C. A. HOGAR

537.311.

5616. Observations on a form of breakdown germanium diodes. A. LEMPICKI AND C. WOO *Proc. Phys. Soc.* [*London*] *B*, **67**, 328–37 (*April*, 1954

The (*I*, *V*) characteristic of germanium diodes shown to depend markedly upon the waveforms use to plot it by oscilloscopic means. When the tim variation of current is studied by the use of micr second pulses a breakdown first observed by Bill occurs [Abstr. 8198 (1952)]. The critical barri temperature at which this breakdown occurs and th barrier radius are obtained by postulating a simp model for the contact. The possibility of the breal down being due to thermal instability is discussed.

537.311.3

5617. New advances in the junction transisto E. W. HEROLD. *Brit. J. appl. Phys.*, **5**, 115–26 (*Apr* 1954).

Presents a survey of some recent United State research into the alloy junction transistor. Th alloy process is described and analyses are give showing how the current amplification factor, varies with geometry, surface recombination an emitter current injection. A simple equivalent circui is derived, based on the physical constants of th transistor. It is then shown that the chief factor limiting frequency response can be reduced in magni tude in an improved radio-frequency amplifie

sistor, which also oscillates at frequencies as as 75 Mc/s. A battery-operated, portable broad- t receiver uses these transistors to obtain per- mance equal to or exceeding that of tube receivers. A.

537.311.4

18. Noise of metal contacts. F. A. P. M. EUNISSEN. *Appl. sci. Res. B*, **3**, *No.* 3, 201–8 (1953). When a direct current of, say, 20 mA flows through electrical contact, a voltage fluctuation of e.g. $^{-6}$ V is observed across the contact in addition to e direct voltage. This fluctuation, the contact noise, is measured as a function of the current, the contact sistance, the contact pressure and the temperature steel balls as well as of copper-plated and gold- ated steel balls. The results may be explained in a alitative way by a discussion of the topography of e contact area. A.

537.311.62 : 535.137

19. The anomalous skin effect and the reflectivity metals. Evaluation of the integrals appearing in the xpressions for the surface impedance. R. B. DINGLE. *ppl. sci. Res. B*, **3**, *No.* 2, 69–99 (1953).

For previous work see Abstr. 6787–8 (1953). eries expansions are derived for the integrals deter- ining the surface impedance of a metal when the kin effect is anomalous. A.

537.311.62 : 535.137

20. The evaluation of the surface impedance in he theory of the anomalous skin effect in metals. A. N. GORDON AND E. H. SONDHEIMER. *Appl. sci. Res. B*, **3**, *No.* 4–5, 297–304 (1953).

A simple method is described for obtaining series expansions for the integrals which represent the surface impedance in the theory of the anomalous skin effect in metals. The results agree with those obtained by means of an intuitive procedure in the preceding abstract. A.

537.312 : 537.531

5621. Conductivity induced in insulating materials by X-rays. J. F. FOWLER AND F. T. FARMER. Letter in *Nature* [*London*] **173**, 317–18 (*Feb.* 13, 1954).

Measurements of induced conductivity in polythene show current $\propto$ (dose rate)$^{0\cdot8}$ and it is deduced that the distribution of electron traps below the conduction band is approximately exponential. Small doses of X-rays (10^4 r) appear to create traps at a deep level which do not decay with time. Similar measurements on Perspex show current $\propto$ (dose rate) and independent of temperature, suggesting that the traps are distributed uniformly in depth with a gap between the superficial and deep levels. F. T. FARMER

537.312 : 543.712 : 621.317.33

5622. The relation between electric conductivity and moisture contents of partially hydrolyzed polyvinyl acetate. T. KOMATA AND Y. SAJI. *J. Inst. Polytech. Osaka City Univ. B*, **2**, 45–50 (*Oct.*, 1951).

A Dunmore type of hygrometer was made and measurements of capacitive reactance at 60 c/s and d.c. resistance between its elements carried out. Results show that the former is predominant at relative humidities $<64\%$ and the latter at high humidities. The change in a.c. resistance with voltage was investigated and it was found that Ohm's law was obeyed only when the relative humidity was greater than a limiting value which decreased from 92 to 81% as the degree of hydrolysis of the material under test increased from 0 to 98%. G. HOWELLS

537.312 : 543.712 : 621.317.33

5623. The relation between electric conductivity and moisture contents of partially hydrolyzed polyvinyl acetate (continued). T. KOMATA AND Y. SAJI. *J. Inst. Polytech. Osaka City Univ. B*, **3**, 59–65 (*Oct.*, 1952).

Direct measurement of the weight of water vapour taken up by films of the material under test was carried out using sensitive glass spring balances. The volume absorption became more effective than surface adsorption at relative humidities greater than a limiting value which depended on the film thickness. A similar result was obtained by studying the rate at which water vapour entered the material by measuring the 60 c/s impedances of three bifilar coils, one on the surface, one 0·004 mm under the surface and one 0·5 mm under the surface. The decrease in impedance found with increasing temperature was due to the increase in the water vapour pressure. It was also considered that above a certain high value of relative humidity a liquid water layer formed on the film surface. G. HOWELLS

537.312.5

5624. Photoconductive and photovoltaic lead selenide layers. H. CHECIŃSKA. *Acta phys. Polon.*, **12**, *No.* 3–4, 194–224 (1953).

A method was worked out for activating thin (about 1 μ) microcrystalline layers of lead selenide. These layers displayed photoconductivity and the internal photovoltaic effect. They were prepared by evaporating *in vacuo* lead selenide which possessed an excess of lead (above the stoichiometric ratio). The layers were treated with oxygen under low pressure and then reduced by heating *in vacuo* with the purpose of securing photosensitivity. The photoconducting layers, when subjected *in vacuo* to an electric current at about 250°c and then rapidly cooled to room temperature, acquired photovoltaic sensitivity. This method of producing photosensitive layers gives sufficiently reproductible results, but further improvements seem possible. The conductivity, photosensitivity and thermoelectric efficiency were measured during various stages of activation of the layers. Changes of type-*n* to type-*p* conductivity were observed during oxidation and the reverse during reduction. The general properties of lead selenide layers are similar to the well-known properties of analogous PbS layers; the main difference consists in their greater sensitivity to the action of oxygen. The behaviour of the layers during activation operations, data obtained from examining the Hall effect, and the strict connection existing between the photoconductivity and the photovoltaic effect agree with the barrier theory of L. Sosnowski (1949). The layers produced by the above method possess a sensitivity to radiation in the range 0·5–3·6 μ. The threshold of sensitivity, i.e. the smallest value of radiation energy causing noticeable effects amounts to 10^{-8} W/cm^2 at room temperature and increases at low temperatures. A.

537.312.5

5625. Sensitization of selenium photoelements to the infrared by mercury vapour. P. Selényi. *Acta phys. Hungar.*, **3**, *No.* 2, 65–73 (1953).

In a previous paper [Abstr. 7287 (1952)] it was reported that whereas the primary photocurrent of a selenium rectifier exposed to the effect of mercury vapour remains practically unchanged the self-resistance and with it the e.m.f. gradually decrease. Closer investigation shows that the colour sensitivity curve is at the same time shifted far into the infrared and a new maximum appears at about 1000 mμ, which in accordance with data found in the literature can be ascribed to the formation of a HgSe layer. The infrared sensitivity (measured with the light of an incandescent lamp and a CS_2-I solution as an infrared filter) amounts to 10–18% of the total sensitivity. A.

537.312.5

5626. A method for the detection of photoelectric emission from hydrocarbons. D. J. Carswell and T. Iredale. *Austral. J. appl. Sci.*, **4**, 329–34 (*June*, 1953).

Details of a method for the detection of photoelectric emission from aromatic hydrocarbons is given, employing a unique type of cell coupled with a sensitive but inexpensive amplifier, capable of recording currents of the order 10^{-12} to 10^{-14} A. The photoelectric threshold of anthracene has been confirmed and the threshold of the three-membered ring analogue, phenanthrene, determined. A.

537.312.5

5627. Lead telluride and lead selenide infra-red detectors. T. S. Moss. *Research*, **6**, 258–64 (*July*, 1953).

A review article, in which the preparation, construction and properties of lead selenide and lead telluride photoconductive cells are described. A.

537.312.5

5628. On the photoconductivity of amethyst quartz. M. K. V. Bappu. *Indian J. Phys.*, **27**, 591–602 (*Dec.*, 1953).

Measurements of photocurrent were made for varying voltages, intensities, radiations and temperatures. A spectral sensitivity curve of photoconductivity duplicates the optical absorption in the visual region identified as the *F*-band. The photocurrent is found to be proportional to light intensity and voltage; in the latter case secondary currents deviate the relationship from strict linearity. Under constant irradiation of light in the maximum of the *F*-band, the crystal is shown to be "excited." Lastly, measurements of photocurrent at different temperatures under radiation sources that yield both the electron primary current and the positive primary current, show that the curves obtained are identical with those obtained by Pohl (1937) in the case of coloured rocksalt. The similarity of the behaviour of amethyst quartz and coloured rocksalt is so very striking that it seems very reasonable to ascribe the colouring of amethyst quartz to *F*-centres caused by high frequency radiations. A.

537.3

5629. Bulk photoconductivity in lead sulphide. D. Soule and R. J. Cashman. Letter in *Phys. Rev.*, 635 (*Feb.* 1, 1954).

Evidence is given by probe studies on synthetic crystals at 770°K of a volume photoconduction wh is enhanced at barriers in the crystals. Probe measu ments of thermoelectric power over the crystal surf indicate *p*-type crystals. G. F. J. GARL

537.31

5630. Modifications of the spectral-response curve a photovoltaic cell under the influence of light-fatig G. Blet. *C.R. Acad. Sci.* [*Paris*] **238**, 578–9 (*Feb* 1954) *In French.*

Using oscillographic recording equipment, spect response curves have been obtained within a f seconds of commencing, and terminating irradiat of the cell with monochromatic radiation of selec wavelength for a period of 1 hr. The records sugg that, as a result of the irradiation, sensitivity diminished throughout the spectral range of respon although the amount of fatigue increases with wa length. No anomaly is found at the wavelength the exciting radiation. A change in the excit wavelength does not appreciably affect the fatig curve, those for irradiation at 4358 Å and 546 being identical within the errors of determinatio The observed fatigue is found to be independent the individual photon energy, depending on the to energy received during irradiation and on the spect sensitivity of the photo-element at the excit wavelength. D. R. BARB

537.312.5 : 621.383.

5631. Spatial variations of the spectral response photomultiplier cathodes. H. Edels and W. Gambling. *J. sci. Instrum.*, **31**, 121 (*April*, 1954).

Experiments show that the cathode of the R.C. 931–A type of photomultiplier gives a spatial variatio of response which is not of the same form for a wavelengths. In particular the form of this respon at 6800 Å is appreciably different from that at 530 and 4800 Å. Thus accurate relative intensity measur ments can only be obtained if the sources concern are so optically aligned that they illuminate the sam cathode area.

537.312

5632. On the temperature dependence of the residua resistance of tungsten in the temperature range 14° to 373°K. E. Krautz and H. Schultz. *Z. Natu forsch.*, **9a**, 125–9 (*Feb.*, 1954) *In German.*

Detailed experimental study of the deviations fro Matthiessen's rule for cold-worked tungsten wires The results agree well with Kohler's theory [Abst 8732 (1950)]. E. H. SONDHEIME

537.312.6

5633. The atomic heat and critical magnetic field o superconducting cadmium. J. R. Clement. Letter i *Phys. Rev.*, **92**, 1578 (*Dec.* 15, 1953).

The inconsistency between recent calorimetri measurements [B. N. Samoïlov, Abstr. 3396 (1954)] and magnetic measurements [Abstr. 6979 (1951), 729 (1952)] can be resolved if a cubic term is added to th

tical magnetic field equation, as was done with In bstr. 1263 (1954)]. H. LONDON

537.312.62

34. Low temperature diamagnetism of electrons in cylinder. W. BAND. Letter in *Phys. Rev.*, **93**, 350 *m.* 15, 1954).

Draws attention to errors in a recent paper of the thor's [Abstr. 6805 (1953)]. G. D. SIMS

537.312.62

35. The phase transition in superconductors. I. Phase propagation below the critical field. T. E. ABER. *Proc. Roy. Soc. A*, **223**, 174–94 (*April* 22, 954).

For Pt II, see Abstr. 6806 (1953). If a superonducting nucleus is created at one end of a long rod supercooled tin, it grows down to the other end ith a velocity, v, of the order of 10 cm/sec. This rocess has been studied experimentally by winding earch coils round the specimens to record the proressive expulsion of the longitudinal magnetic field; n particular v has been measured as a function of eld strength and temperature, for a number of pecimens of varying radius, conductivity and surface ondition. It is shown that v is governed by the rogress of a thin superconducting filament that oots out from the nucleus along the surface of the pecimen. Subsequently this filament closes up to orm a sheath of the superconducting phase, leaving ome flux enclosed which takes several seconds to scape, but these later stages of the transition are nly briefly discussed. A quantitative theory is eveloped to account for the rate of advance of the riginal filament, by considering the conditions for onservation of energy during propagation. It is ssumed that the two controlling factors are the nterphase surface tension and the electromagnetic lamping effect of the eddy currents set up in the ormal phase ahead of the filament. The theory is omplicated by an interesting phenomenon analogous o the anomalous skin effect, which is observed when he electronic mean free path becomes comparable with the filament thickness; a dimensional analysis f the results reveals that the eddy currents may ehave "classically," "anomalously" or somewhat etween the two, depending on the conditions of the xperiment. Only in the anomalous region is the heory completely successful, but its failure elsewhere an be traced to limitations in the rather simple model which is considered. Values of the interphase tension re deduced from the experimental data; these are in greement with previous estimates based on intermediate state work, but they are more extensive and probably more reliable. They are briefly compared with the predictions of Ginsburg and Landau (1950) nd Pippard (1951, 1953). A.

537.312.7

5636. The spatial generalization of Zener's formula for internal field emission. J. HOMILIUS AND W. FRANZ. *Z. Naturforsch.*, **9a**, 5–14 (*Jan.*, 1954) *In German.*

A mathematical treatment of conduction due to the excitation of electrons from valency to conduction bands in an insulating crystal due to a strong electric field is applied to different crystallographic directions. C. G. MORGAN

537.312.9

5637. Effect of elastic strain on the electrical resistance of metals. G. C. KUCZYNSKI. *Phys. Rev.*, **94**, 61–4 (*April* 1, 1954).

The strain coefficients of electrical resistivity of some eighteen metals and alloys have been determined experimentally. It has been shown that for most metals the free electron theory accounts qualitatively for the observed effects. In the case of bismuth and antimony, the discussion of the possible deformation of the Brillouin zones of these metals with strain seems to explain their abnormal behaviour. A.

537.323

5638. On the subject of the thermoelectric properties of bismuth. J. SAVORNIN AND A. POGGI. *C.R. Acad. Sci.* [*Paris*] **238**, 656–7 (*Feb.* 8, 1954) *In French.*

The thermoelectric power of Bi/Cu couples decreases monotonically with increasing temperature in the range 10 to 230°C. The value is of order $60–70 \times 10^{-6}$ volts/degree and is independent of the temperature difference used in the measurements.

C. A. HOGARTH

537.36 : 538.639

5639. Theory of electromagnetophoresis. I. Magnetohydrodynamic forces experienced by spherical and symmetrically oriented cylindrical particles. D. LEENOV AND A. KOLIN. *J. chem. Phys.*, **22**, 683–8 (*April*, 1954).

The first of a series dealing with the theory of the electromagnetokinetic effect. This effect consists of the exertion of a force upon a body submerged in a fluid which is traversed by an electric current and a transverse magnetic field. In this communication the conditions for equilibrium of an homogeneous fluid are established and forces upon particles suspended in the fluid are determined. The computations are carried out for spherical bodies and long cylindrical bodies oriented parallel to the magnetic field, to the electric current and to the exerted force. It is shown that the effect could be observed with suspended particles which differ from the surrounding fluid in the value of their electrical conductivity or dielectric constant, and/or their magnetic permeability. A.

537.362

5640. Electrokinetic phenomena on open surfaces. O. N. GRIGOROV AND N. K. BARABANSHCHIKOVA. *Dokl. Akad. Nauk SSSR*, **93**, *No.* 1, 89–92 (1953) *In Russian.*

The electro-osmotic transfer of liquid through a thin slit between two pieces of glass gives the same value of the ζ-potential as determinations by the usual method with powdered glass, and the difference in potential, ΔE, produced by the movement of electrolyte across a rapidly rotating Perspex surface, divided by the r.p.m., gives a plot against the log concentration similar to that of $\Delta E/P$ against log C, derived from forcing liquid under a pressure difference P through powdered Perspex. R. C. MURRAY

537.362

5641. Electroosmosis and streaming in natural and synthetic fibers. G. J. BIEFER AND S. G. MASON. *J. Colloid Sci.*, **9**, 20–35 (*Feb.*, 1954).

ELECTRIC DISCHARGES 537.52

537.52

5642. On the erosive effect of a jet of neutral particles arising from the electrical discharge of a condenser. V. Hermoch and K. Krtička. Letter in *Czech. J. Phys.*, **2**, 149–51 (1953) *In Russian.*

A condenser was discharged across electrodes, and particles emitted normal to the electrode surfaces were caught on a plate. A constant discharge of 32 joules was used and variations of the erosive effect on the plate with distance, number of repetitions of the discharge and electrode material were noted. When the plate was nearer the anode than 5 mm superficial melting was observed, pits formed opposite the anode being greater than those opposite the cathode. The loss of anode material was correspondingly greater. Cu, Fe and Al all behaved similarly as electrodes.

A. L. MACKAY

537.52 : 538.632

5643 An elementary theory of the Hall effect in a gas discharge. W. B. Thompson. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. T/R* 1345, 8 *pp.* (1954).

The Hall potential is shown to be $V = H(w/c)D + W_e \log I_1/I_2$, where H is the magnetic field, w the drift velocity, D the tube width, $W_e = kT_-/e$, where T_- is the electron temperature and I_1, I_2 the ion currents to the two walls. This potential is calculated for two models in plane geometry of the discharge and the results are: for the diffusion model $V = 0{\cdot}5\ H(w/c)D$, and for the free fall model $V = 0{\cdot}875\ H(w/c)D$, where H is assumed small.

A.

537.523.3

5644. Point corona against a plane covered by an insulating film. C. H. Hertz. *Ark. Fys.*, **7**, *Paper* 31, 399–400 (1954).

Briefly describes experiments with point-plane geometry in which the breakdown voltage was reduced by covering the plane electrode with shellac. The effect is due apparently to holes in the shellac, giving increased local field strengths.

J. D. CRAGGS

537.523.5

5645. The phenomenon of moveable single and multiple hot-spots at the cathode of an electrical arc. G. Ecker. *Z. Phys.*, **136**, *No.* 5, 556–72 (1954) *In German.*

An extension of previous work [Abstr. 6815 (1953); 3513 (1954)] on the contraction theory of the arc. The occurrence of stationary and moving, single and multiple arc spots in the high-pressure mercury-arc are discussed. Thermionic emission, field emission and the contraction process are considered to contribute to the cathode current in the arc.

C. G. MORGAN

537.525

5646. Calculated values of the parameters of noble gas discharges. W. J. Graham and A. J. Ruhlig. *Phys. Rev.*, **94**, 25–9 (*April* 1, 1954).

Molar properties of gaseous discharges are determined by the transport cross-section which is expressible in terms of the phase shifts defined in electron-atom scattering theory. $\sigma_t(v)$ was calculated for helium, neon, and argon using values of phase shifts η_0 to η_6 derived by Westin from existing scattering data. Druyvesteyn distribution functions were cal lated for E/p from 0·1 to 1·0. Average values w then calculated for collision frequency, drift veloc diffusion coefficient, and average energy. Also, lision frequency and elastic energy loss were cal lated using Maxwell distributions for kT_e up to 10 These calculations are particularly useful at very energy, where extrapolation of phase shifts is m reliable than of the experimental data. Values o are compared with those of Barbiere (taken fr direct scattering data); values of drift velocity somewhat lower than Nielsen's data.

537.52

5647. Positive point-to-plane corona studies in a M. Menes and L. H. Fisher. *Phys. Rev.*, **94**, (*April* 1, 1954).

Formative time lags for the development of positive point-to-plane corona in dry air w measured oscillographically at pressures rangi from atmospheric to a few centimetres of Hg. Stud with a photomultiplier tube show that the obser formative lags are associated with a filament streamer type of corona. These corona formati lags are of the order of 10^{-7} sec even near thresh and vary much more slowly with overvoltage than uniform field formative lags in air. The results in cate that no long build-up process is associated w the formation of the filamentary streamer type corona in air, and in particular rule out any catho secondary mechanism from playing a role in t formation. Near atmospheric pressure, with t experimental conditions used, the corona formati time lags were often too short to be resolved fr the statistical scatter; when resolvable they were fou to be too long to be ascribed solely to a single tran time of the initiating electron avalanche across t high field region of the gap. The results therefo do not preclude a fast build-up process in the gas pr ceding streamer formation. Threshold measuremen on both impulse and d.c. corona indicate that t steady glow type of corona has a different thresho than the streamer type. No formative lag data on t steady glow corona were obtained.

537.525

5648. Origin of retrograde motion of arc catho spots. A. E. Robson and A. von Engel. Letter *Phys. Rev.*, **93**, 1121 (*March* 1, 1954).

The new mechanism proposed involves the regi where the constricted discharge column meets t high-field cathode fall region in the discharge. T effect of the external magnetic field (*a*) can be unde stood if its effect is balanced against that due to t self-magnetic field (*b*) of the discharge in the abo region. The relative preponderance of (*a*) or depends on the external magnetic field and the di charge properties in a manner consistent wit observations.

J. D. CRAGG

537.525.5 : 537.525.

5649. The theory of the anode fall. W. Bez an K.-H. Höcker. *Z. Naturforsch.*, **9a**, 72–81 (*Feb* 1954) *In German.*

A detailed treatment of the space charge regio near the anode in glow and arc discharges. Th anode fall is divided into three arbitrary zones, lyin

etween the undisturbed plasma and the anode, and as a thickness $\sim 10^{-3}$ cm (pressure ~ 1 mm Hg). alculations are made of, e.g. the variation of electric eld through the fall region. J. D. CRAGGS

537.525.6

5650. The secondary electron resonance mechanism f low-pressure high-frequency gas breakdown. A. J. IATCH AND H. B. WILLIAMS. *J. appl. Phys.*, **25,** 17–23 (*April*, 1954).

Breakdown field strengths have been measured in ir and hydrogen at pressures of the order of 1 micron lg and frequencies from 25 to 90 Mc/s between flat netal electrodes at separations from 1 to 4 cm. By uddenly applying a high voltage and then lowering it lowly an upper breakdown curve has been observed. his new curve can be combined with the lower break-lown curve and cut-off frequency such as reported reviously by the Guttons, and by Gill and von Engel o form the boundaries of a breakdown region in the requency-field strength domain. The simple secon-lary electron resonance theories developed by Danielsson and Gill and von Engel have been extended by the semi-empirical determination of mini-num and maximum limiting values of the electron-emission phase angle, a minimum limiting value of electron arrival energy, and a ratio between electron rrival and emission velocities. A.

537.525.72

5651. Some observations on the effect of light on 'silent" electrical discharge through iodine vapour. S. R. KHASTGIR AND P. S. V. SETTY. *Proc. Nat. Inst. Sci. India*, **19,** 631–9 (*Sept.–Oct.*, 1953).

Some experimental results with iodine vapour at saturation pressure inside a discharge tube fitted with external "sleeve"-electrodes and excited by varying voltages of 50 c/s are given. The results have shown wo distinct types of current pulses in iodine vapour nder "silent" electrical discharge. The oscillo-graphic evidence strongly suggests that the two types are of different origin. The observed positive Joshi effect near the "threshold" potential is attributed to the initiation of what have been called the Townsend pulses by the incidence of light and the observed negative Joshi effect is considered as mainly due to the photo-suppression of what have been called the "discharge" pulses. The experimental results con-firm the view regarding the origin of the "discharge" pulses. An account is also given of parallel sets of experimental results on Joshi effect observed by directly measuring the discharge current and also by detecting in a radio receiver the r.f. oscillations as modulated by the a.f. pulses in the "silent" discharge. A.

537.525.8

5652. Determination of vapour density behind the anode and behind the cathode of a discharge tube. A. M. SHUKHTIN. *Dokl. Akad. Nauk SSSR*, **92,** *No.* 2, 289–91 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-193.

Describes the use of an interferometer method to measure variations in gas density in various parts of glow discharges, and in particular behind the anode and cathode. The discharge was maintained in Cs vapour at 5 A. Behind the anode the change in concentration of neutral atoms was $\Delta N \simeq 10^{13}/\text{cm}^3$, less than 1% of the mean particle density. J. D. CRAGGS

537.525.8

5653. Use of a narrow-band amplifier in oscillographic investigation of the electron velocity distribution functions in an electrical discharge. G. M. MALÝSHEV AND V. L. FEDOROV. *Dokl. Akad. Nauk SSSR*, **92,** *No.* 2, 269–71 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-186.

Gives, schematically, a method by means of which the second differential d^2I/dV^2 of a probe I–V (current-voltage) characteristic may be displayed on a cathode-ray-tube screen. The method is used to determine variations of electron energy distributions, which are given directly by the $d^2I/dV^2 - V$ plots, through individual striations in a low-pressure glow discharge. J. D. CRAGGS

537.525.8

5654. Diffusion cooling of electrons in ionized gases. M. A. BIONDI. *Phys. Rev.*, **93,** 1136–40 (*March* 15, 1954).

The term "diffusion cooling" is used to describe the situation in which the average energy of an electron swarm is reduced by the diffusion of the faster electrons to the container walls. In the present experiment, measurements of the ambipolar diffusion loss of electrons during the afterglow reveal the presence of diffusion cooling by the reduction in the ambipolar diffusion coefficient. In low-pressure neon and argon afterglows the "thermal contact" between electrons and gas atoms is poor; consequently the diffusion loss of the fast electrons causes a large reduction in electron "temperature" with respect to the gas temperature. When small amounts of helium are added, the thermal contact is greatly improved, and therefore the electrons are restored to thermal equilibrium with the gas. These experimental observations confirm the predictions of a qualitative theory given for the process. A.

537.525.8 : 537.562

5655. On the theory of ion currents to probes at low pressures. YU. M. KAGAN AND V. I. PEREL'. *Dokl. Akad. Nauk SSSR*, **91,** *No.* 6, 1321–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-179.

Obtains a simple relation between the ion current for large negative probe potentials and the electron ("diffusion") current at the space potential. The treatment is a refinement of the original Langmuir theory and is comparable with those given by Boyd [Abstr. 5016 (1950)] and by Wenzl [Abstr. 5866 (1950)]. Confirmatory experimental data are given for mercury discharges. J. D. CRAGGS

537.525.8 : 621.387

5656. Effects of ambient-temperature variations on glow-discharge tube characteristics. F. A. BENSON AND G. MAYO. *J. sci. Instrum.*, **31,** 118–20 (*April*, 1954).

Temperature/running-voltage characteristics of 9 British types of glow-discharge tube and one German type have been obtained and are discussed. Many of the curves exhibit minima, i.e. the temperature coefficient of running voltage changes from negative, through zero, to positive values. A.

X-RAYS 537.531

537.531 : 535.33.07

5657. A Geiger counter vacuum spectrometer and its use for the study of soft X-ray lines. J. L. ROGERS AND F. C. CHALKLIN. *Proc. Phys. Soc.* [*London*] *B*, **67**, 348–56 (*April*, 1954).

A ruled grating vacuum spectrometer has been constructed in which the radiation is detected and its intensity measured by means of a Geiger counter. The working range of the instrument is about 20–200 Å. An outline is given of the principles of its design, of the procedure of adjustment, and of the method of finding the instrumental line-width. The operation of the instrument is illustrated by experiments on the shape of the $M\zeta$ line of molybdenum and on the N "doublet" of tungsten, in which a new structure has been detected, and which has been analysed. A.

537.531 : 535.343

5658. X-ray *K*-absorption edge-energies of elements Li, Be, B and C. H. FUJIMOTO AND S. CHIBA. *Sci. Rep. Tôhoku Univ. First Ser.*, **35**, 154–64 (*Dec.*, 1951).

The ionization energies of atoms with electronic configurations ($1s\,2s$) ^3S and ($1s\,2s^2$) are calculated numerically. Employing these values and experimental or approximate ionization potentials of various atomic configurations, *K*-absorption edge-energies of isolated atoms Li, Be, B and C are calculated following Skinner's approximate method, and are compared with energies corresponding to observed *K*-absorption edges or short wavelength limits of emission bands. Agreement is obtained within a few percent. X-ray *K*-term values are also given, which are compared with Braunbeck's theoretical values calculated by a different method. A.

537.531 : 535.343

5659. X-ray *K*-absorption spectra of potassium in KF, KCl, KBr and KI. S. KIYONO. *Sci. Rep. Tôhoku Univ. First Ser.*, **36**, 1–17 (*July*, 1952).

A curved quartz-crystal vacuum spectrograph, having 50 cm radius of curvature of the crystal, was used and the X-ray *K*-absorption fine structures of potassium contained in its halides were photographed. The dispersion of the spectrograph was 5·2 X-units/mm on photographic plates which corresponds to 5·5 eV/mm. Microphotometer records of absorption spectra are shown. Wavelengths of fine structures are measured. The energy separations of the absorption structures from the main absorption edges are discussed. A.

537.531 : 535.345

5660. X-ray *K*-absorption spectra of potassium in various compounds. S. KIYONO. *Sci. Rep. Tôhoku Univ. First Ser.*, **36**, 236–49 (*Dec.*, 1952).

Fine structures in X-ray *K*-absorption spectra of potassium contained in various compounds were photographed by means of a curved quartz-crystal vacuum spectrograph, having 50 cm radius of curvature of the crystal. Twelve samples were studied: K_2CO_3, $KHCO_3$, $KClO_3$, $K_2Cr_2O_7$, $K_3Fe(CN)_6$, $K_4Fe(CN)_6.3H_2O$, KHF_2, KIO_3, $KMnO_4$, KNO_3, $KHSO_4$ and muscovite. Microphotometric records of absorption spectra are shown. Wavelengths λ of fine structures, wavelength differences $\Delta\lambda$ measu from the main edge, and corresponding energy va ν/R, $\Delta\nu/R$, ΔV are given. $K_2Cr_2O_7$, $KMnO_4$, K and muscovite show double main edges. Second structures indicate certain characteristic features each compound; generally the complicated co pounds tested show rather smooth second structures.

537.531 · 535.

5661. On structure of X-ray *K*-absorption edge potassium in potassium halide. A. MORITA. *Sci. R Tôhoku Univ. First Ser.*, **36**, 256–8 (*Dec.*, 1952).

A model is proposed to explain the structures X-ray *K*-absorption edge of potassium in potassi halides. The vacancy left in the X-ray shell o potassium ion allows the formation of bound sta below the conduction band and the transitions these bound states from the X-ray shell gives structure of the absorption edge. On the basis this model, some calculations are made for KF a KCl.

537.531 : 535.8

5662. Combination of X-ray focussing mirrors in X-ray microscope. Y. T. THATHACHARI AND G. RAMACHANDRAN. *J. Indian Inst. Sci. A*, **34**, 67– (*April*, 1952).

A theoretical study of combinations of spheri crystal reflectors which can give X-ray images simi to those in an optical microscope. The only possi combination is found to be that in which both t mirrors are concave and both have the same radius curvature, so that the two mirrors form parts of t same spherical surface. Under these conditions, t Bragg relation is satisfied at both mirrors for a number of multiple reflections. By making use N reflections, the optical path of the "microscope" f given magnification can be reduced to $1/N$ of th required with only one reflection.

537.531 : 539.1

5663. General considerations regarding the dos metry of roentgen and gamma radiation. W. OOSTERKAMP. *Appl. sci. Res. B*, **3**, *No.* 2, 100– (1953).

A distinction is made between the quantiti "irradiation," which characterizes the roentgen radi tion at a certain place as to its capacity of producin ions in air and which is measured in roentgen, an "dose," which characterizes the energy imparted t the material subjected to the roentgen radiation an which is measured in ergs per gramme or multiples ergs per gramme. The methods by which both quanti ties can be measured are analysed. A measurement o irradiation at photon energies above 3 MeV has no yet been made. The correlation between irradiatio and dose is discussed: Irradiation is in air-equivalen or nearly air-equivalent materials at moderate photo energies, a fair measure of dose; in non air-equivalen tissue, the differences in mass absorption coefficien between this tissue and air should be taken int account; at discontinuities in the atomic compositio the increased generation of secondary electrons i materials with higher atomic number will also cause a increased ionization in neighbouring tissues wit

ver atomic number; at photon energies above MeV there is an increasing discrepancy between adiation and dose at the same place. A.

537.531 : 539.166

64. **Penetration of X- and gamma rays to extremely eat depths.** U. FANO. *J. Res. Nat. Bur. Stand.*, **51**, i–119 (*Aug.*, 1953).

Earlier work on the asymptotic trend of the X-ray tensity at great distances from a source is reviewed nd completed in various aspects. The asymptotic w is shown to be the same as in the "straight-ahead" pproximation (which disregards deflections) whether ne primary energy is higher or lower than the energy f minimum absorption, provided a constant is re-laced by the eigenvalue of a suitable Wick equation. he penetration in directions oblique to the source irection hardly ever attains its asymptotic trend when ne source energy is lower than the energy of minimum bsorption. This situation raises a difficult problem egarding the penetration law in the range of great epths where the asymptotic trend is being approached ery slowly. A.

537.531 : 539.166.74

Anomalous X-ray scattering of heavy atoms near *K*- nd *L*-edges. *See Abstr.* 5943–4

537.531.08

665. **Investigations with a new apparatus for iso-ose measurement having a cadmium sulphide cell.** I. SIMON AND H. THIEL. *Ann. Phys.* [*Leipzig*] **14**, *No.* 1–2, 54–63 (1954) *In German.*

A small vacuum-mounted CdS cell, sensitive to X-rays, is described. The dimension of the sensitive rea approaches a point, so that the cell can be used or measuring intensities which change rapidly with istance. Isodose curves (in the plane perpendicular o the direction of the beam) plotted with this instru-nent, are shown for grenz-ray tubes and for 180 kV herapy tubes. Shapes of these curves are discussed n the light of the focal spot pictures (given) of the X-ray tube targets. D. MABBS

537.531.08 : 621.386.82 : 621.317.723

5666. **A universal X-ray dosemeter.** J. FRANSEN AND W. J. OOSTERKAMP. *Trans Instrum. Meas. Conf.*, **1952**, 93–4.

The instrument is a dynamic electrometer provided with a choice of ionization chambers and input circuits so that integrated doses and dose rates can be measured over a wide range of values, and covering X-ray qualities from 0·02 mm Al half-value layer to 2·5 mm Cu half-value layer. A built-in calibration circuit is included. L. E. MUSSELL

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533.2

5667. **On the emission of negative particles, a phenomenon which accompanies the influence of standing a metal surface in a gas.** F. ROUBÍNEK AND R. SEIDL. *Czech. J. Phys.*, **2**, 84–101 (1953) *In German.*

A theory to explain the phenomenon of the emission of negative particles from metals which have been exposed to gases and otherwise treated [Abstr. 2657 (1951)], which depends upon the theory of oxidation of metals, is developed. Agreement is obtained between the theoretical predictions and measurements made in the study. C. G. MORGAN

537.533.2

5668. **Some experiments on Kramer exoelectrons.** O. BRUNA, K. LINTNER, H. MÜLLER AND E. SCHMID. *Z. Phys.*, **136**, *No.* 5, 605–11 (1954) *In German.*

The blackening of a photographic emulsion by freshly worked (with a file or emery) metallic surfaces of Ni and Al placed in contact with the emulsion is described. The cold emission of electrons from the same surfaces was measured with a Geiger counter and was found to begin at about 70°c and to increase to a maximum with increasing temperature when the surrounding gas is A (max. at 230°c) or H_2 (max. at 190°c). No maximum in the emission was found with air as the surrounding gas. The emission occurring during the freezing of Wood's metal and of Hg was measured. The emission from freshly etched surfaces of Al as a function of time was found to be hyperbolic. Views regarding the source of the energy required for the release of the electrons are discussed. W. GOOD

537.533.3

5669. **Electron-optical method for imaging objects with magnetic nonhomogeneities.** G. V. SPIVAK, N. G. KANAVINA, I. N. CHERNYSHEV AND I. S. SBITNIKOVA. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 3, 541–3 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-202.*

A new method for observing magnetic inhomogeneities in a surface is described. The surface is made the cathode of an emission electron microscope; emission is produced by electron or ion bombardment. The magnetic field variations produced by inhomogeneities result in image contrast. The method is claimed to have several advantages over Marton's schlieren method. Micrographs (×30) are shown. M. E. HAINE

537.533.3 : 537.591.5

5670. **Experimental determination of electron orbits in the field of a magnetic dipole. I.** E.-Å. BRUNBERG. **II.** E.-Å. BRUNBERG AND A. DATTNER. *Tellus*, **5**, 135–56 (*May*); 269–93 (*Aug.*, 1953).

An analogue method for determination of electron orbits in a magnetic dipole field was developed by Malmfors several years ago. The method is in principle a scale model experiment in a vacuum chamber where the results are obtained by measuring the deflection of an electron beam in the field of a "terrella." This method has been further developed, and particle orbits corresponding to the following momenta have now been measured: (1) $2\times10^9 - 10^{10}$ *eV/C*; Orbits arriving at magnetic latitude 58° in E, S, W and N directions at zenith angles of 0°, 20°, 40°, 60°, 80°. Orbits arriving from zenith at different latitudes beginning with 38° and continuing at intervals of 2 degrees up to the pole. (2) $10^{10} - \infty$ *eV/c*. Orbits arriving at magnetic latitude 0°, 10°, 20°, 30°, 40°, 50°, 60°, 70°, 80°, and 90° from E. S, W and N directions at zenith angles of 0°, 8°, 16°, 24°, 32°, 40°, 48°, 56°, 64°, 72°, and 80°. The direction of orbits

far away from the dipole is published as a function of momentum. The particles are assumed to move towards the earth and to be positively charged. A.

537.533.3 : 538.082

Electron-optical shadow method of magnetic-field mapping. *See Abstr.* 5785

537.533.33

5671. A simple "Stigmator" for electron lenses. S. Leisegang. *Optik*, **11**, *No.* 2, 49–60 (1954) *In German.*

A device is described for the correction of the astigmatism of the objective lens in an electron microscope to a value permitting a resolving power of 10 Å. The corrector consists of two pieces of soft iron placed in the polepiece bore below the air gap. The corrector elements can be rotated, and also displaced axially. A method of correcting the lens astigmatism is described in detail. A.E.I. RESEARCH LABORATORY

537.533.331

5672. On the determination of the electron-optical characteristics of electrostatic lenses. III. W. Lippert and W. Pohlit. *Optik*, **11**, *No.* 4, 181–6 (1954) *In German.*

For Pt II, see Abstr. 2479 (1954). This paper completes the work of the previous parts. The experimental results are compared with the theoretical results of Regenstreif. It is concluded that agreement exists between the theoretical and experimental results only over a limited range of geometry, and therefore Regenstreif's solutions cannot yet be regarded as complete. A.E.I. RESEARCH LABORATORY

537.533.35

5673. A method of focussing in electron microscope. S. Arai. *Sci. Rep. Tôhoku Univ. First Ser.*, **35**, 151–3 (*Dec.*, 1951).

537.533.35

5674. Image formation in the electron microscope. W. Glaser. *Optik*, **11**, *No.* 3, 101–17 (1954) *In German.*

This paper was presented as an introductory lecture at the German Electron Microscope Conference held in Innsbruck during September, 1953. In it, the author describes the image formation in the electron microscope, mainly in terms of wave optics and double Fourier transforms. The paper is mainly non-mathematical. A.E.I. RESEARCH LABORATORY

537.533.35

5675. A low-distortion electromagnetic double projector lens for electron microscopes. L. Wegmann. *Optik*, **11**, *No.* 4, 153–70 (1954) *In German.*

The condition for no image distortion in the electron microscope is worked out for a double projector lens system. A particular application of the results is described using two lenses and simple circuits. The resulting distortion is practically negligible over a range of magnification of three to one.

A.E.I. RESEARCH LABORATORY

537.533.35 : 539.27

5676. Introduction to electron microscopy. C. E. Hall. *New York: McGraw-Hill Book Company* (1953) 451 + ix *pp.*

Review in *Amer. J. Phys.*, **22**, 97 (*Feb.*, 1954).

537.533.35 : 53

5677. Recent developments in electron microsc V. E. Cosslett. *J. photogr. Sci.*, **1**, 64–70 (*Ma April*, 1953).

A brief survey. 17 refs.

537.53

5678. An electro-static beta-ray spectrometer, u a spherical condenser. M. C. Joshi and B. V. Thos *Proc. Indian Acad. Sci. A*, **38**, 367–75 (*Nov.*, 1953)

A spectrometer has been constructed for study weak sources, and its performance has been te with accelerated electron beams. The device, wh is intended for low energy range of electrons, has, the slit system employed, the resolving power of 1 with transmission 1/44 of a sphere which compa favourably with that in other types of spectrome The electron energy (in keV) focused is 4·37 times voltage (in kV) on the electrodes.

537.533.35 : 539.165

5679. Design and trajectories for a magnetic nuclear spectrometer. L. A. Kiley, W. S. Emmeri Y. Nogami and J. D. Kurbatov. Note in *Rev. Instrum.*, **24**, 1145–6 (*Dec.*, 1953).

A water-cooled, magnetic-lens type spectrome for β and γ measurements up to 6 MeV incorpora five exchangeable baffle systems to accommodat range of emission angles and therefore resoluti The instrument was designed by measuring the a magnetic field and the appropriate trajectories w determined graphically by a ray tracing meth The 26 in. system has a calibration constant 637 gauss. cm/ampere and can focus electrons up about 6 MeV. Under these conditions the inst ment has an acceptance angle of 1·2% of a sphere a a half width resolution of 2·3%. D. R. CHI

537.533.

5680. A device for the correction of the chroma error in electron diffraction. R. Bernard and M Salvat. *Optik*, **11**, *No.* 4, 187–94 (1954) *In German*

A lens arrangement is described, for use in diffra tion cameras, that makes the diameter of diffracti rings practically independent of accelerating volta and lens current. The independence of acceleratio voltage is brought about by inserting a weak magnet lens between specimen and fluorescent screen. T lens field strength is made practically independe of exciting current by means of an auxiliary magnet circuit. A.E.I. RESEARCH LABORATOR

537.533.

5681. Relativistic scattering of electrons and t Born approximation. E. Corinaldesi. Letter *Nuovo Cimento*, **11**, 200–2 (*Feb.*, 1954).

As the electron energy goes to ∞, both Bor approximation and the exact calculation give zer scattering amplitude for angles $\theta \neq 0$, and infini amplitude for $\theta = 0$. Hence there is no reason t disbelieve that Born approximation improves wit increasing energy. G. E. BROW

537.533.

5682. Interaction of beta particles with matte R. H. Müller. Letter in *Phys. Rev.*, **93**, 891 (*Feb.* 1 1954).

The results of back-scattering of 2·0 MeV β-par ticles from elements and compounds are discusse

Discontinuities in the back-scattering from elements occur at the end of each period of the periodic system. G. E. BROWN

537.533.74

5683. The sign of the phase shift in the elastic scattering of electrons. D. R. YENNIE, D. G. RAVENHALL AND E. BARANGER. Letter in *Phys. Rev.*, **93**, 1128 (*March* 1, 1954).

The anomalous phase shift arising from the extended nuclear charge in the scattering of electrons by nuclei is shown to be less than zero, rather than to approach zero through positive values with increasing l as previously asserted [Abstr. 6559 (1952)]. G. E. BROWN

537.533.74

5684. Scattering of high-energy electrons by heavy nuclei. E. U. BARANGER. Letter in *Phys. Rev.*, **93**, 1127 (*March* 1, 1954).

The use of the WKB approximation to calculate the phase shifts is outlined. G. E. BROWN

537.533.74

5685. A variational calculation of the elastic scattering of electrons by hydrogen atoms. H. BOYET AND S. BOROWITZ. *Phys. Rev.*, **93**, 1225–7 (*March* 15, 1954).

The Schwinger variational method for three-body collisions is applied to the calculation of elastic scattering of electrons by hydrogen atoms in the energy range 0–10 volts. When a Born trial field is used, the contributions of the ground state and all the excited states including the continuum can be calculated. The former contribution is equivalent to the static field approximation and the latter contributions give the corrections to it. When these are included, the results do not agree with those of Massey and Moiseiwitsch who use a different approximation. The Schwinger variational method with a Born trial field is concluded to be unsatisfactory in this energy range. A.

537.533.74

5686. An experimental measurement of the gyromagnetic ratio of the free electron. W. H. LOUISELL, R. W. PIDD AND H. R. CRANE. *Phys. Rev.*, **94**, 7–16 (*April* 1, 1954).

The gyromagnetic ratio of the free electron is measured by a method which is an extension of the classical double-scattering experiment. A magnetic field is interposed between the first and second scattering foils, whose direction is parallel to the path followed by the electrons. The electron spins precess in the magnetic field, resulting in a rotation of the plane of maximum asymmetry, as observed after the second scattering event. In the experiment reported, the rotation is approximately 1800 degrees. In the motion of the electron between the two scatterers the small lateral component of velocity gives rise to a "cyclotron" motion whose frequency is, theoretically, the same as the spin precession frequency to within about one part in a thousand, The cyclotron motion, therefore, furnishes a convenient reference frequency, but it also introduces problems in that it causes the asymmetries which have their origin in geometrical misalignment, finite aperture, etc., to follow the rotation of the spin asymmetry. By comparing all measurements made with the foils of high atomic number with measurements made with an aluminium foil of equal scattering power, and by further precautionary procedures and cross checks, the spin asymmetry is separated from asymmetries of other origin. The result, for 420 keV electrons and gold scatterers, is $g = 2{\cdot}00 \pm 0{\cdot}01$. Plans for a more precise measurement are mentioned. A.

537.533.74 : 539.166.74

5687. Polarization phenomena of electrons and photons. I. General method and application to Compton scattering. F. W. LIPPS AND H. A. TOLHOEK. *Physica*, **20**, 85–98 (*Feb.*, 1954).

A general method is developed, which introduces 3-dimensional polarization vectors ξ and ζ for the characterization of the polarization of photons and electrons in processes involving both. The transition rates (giving the cross-sections) are expressed as the trace of the product of a number of matrices. These matrices include density matrices representing the initial and final states. All the matrices in the product have the form of sums of Pauli spin matrices (though they are related to photons as well as to electrons) so that the calculation of the trace is straightforward. The results for cross-sections contain all polarization vectors ξ and ζ linearly. The method is applied to Compton scattering, with all polarizations taken into account. A.

537.533.75

5688. The penetrability of silver foils for slow electrons. W. BERGER. Note in *Naturwissenschaften*, **41**, *No.* 3, 59 (1954) *In German.*

Using an electron microscope it was shown that early anomalous results on the transmission of slow electrons by thin chemically deposited silver films was due to the presence of holes. J. HUGHES

537.533.75

5689. The specific ionization and energy loss of a fast charged particle. J. R. ALLEN. Letter in *Phys. Rev.*, **93**, 353 (*Jan.* 15, 1954).

From known values of absorption coefficients and dielectric constant the total primary excitation and ionization due to fast electrons and the total energy absorption are calculated for silver bromide. Calculations of the kinetic energy of primary ejected electrons are compared with measurements. C. G. MORGAN

537.533.75

5690. Energy loss of charged relativistic particles and the element periods. T. WESTERMARK. *Phys. Rev.*, **93**, 400 (*Feb.* 1, 1954).

The stopping power per electron for charged relativistic particles is known to be a function of the electron density of the matter traversed. As the latter is a periodic property of the elements, the stopping power should also be periodic. A calculation shows the energy loss to have maxima at the alkali metals and minima between them. It is suggested that this effect partly caused the periodicity found long ago by Crowther in the absorption of Pa^{234} β-rays. Differences in stopping power for chemical isomers and element modifications are also discussed. A.

537.533.75

5691. Energy loss and straggling of electrons. C. WARNER, III, AND F. ROHRLICH. *Phys. Rev.*, **93**, 406–7 (*Feb.* 1, 1954).

The energy-straggling distribution and the most probable energy loss for 15·7 MeV electrons in Cu is calculated. Corrections for the resonance effect, bremsstrahlung, the polarization effect and multiple scattering are included. The results are in very satisfactory agreement with recent experiments. The discrepancy in the most probable energy loss in Au is also discussed. A.

537.533.75 : 537.533.8

5692. Energy spectrum resulting from electron slowing down. L. V. SPENCER AND U. FANO. *Phys. Rev.*, **93**, 1172–81 (*March* 15, 1954).

The equation for the slowing down of electrons is cast in a form suitable for numerical calculations. Pilot calculations have been performed for source energies of $4mc^2$ and $80mc^2$ in Al and Pb. The spectrum of slowed-down electrons, which would be the reciprocal of the stopping power under the assumption of continuous slowing down, departs substantially from this elementary solution at the upper and lower energy ends of the spectrum. The departures are large throughout when bremsstrahlung is important. The accumulation of secondary knock-on electrons is also included in the calculations. A.

537.533.79 : 621.373.423 : 621.385.16.029.6

5693. Frequencies and powers of the waves radiated from a magnetic undulator. R. COMBE AND M. FEIX. *C.R. Acad. Sci.* [*Paris*] **237**, 1660–2 (*Dec.* 21, 1953) *In French.*

For background see Abstr. 3549 (1954). The results for the trajectory given in the earlier paper lead to dimensions for the undulator which are very different from those given by the classical approximations. However, the total radiated power is of the same order. A. H. W. BECK (R)

537.533.8

5694. Threshold of secondary electron emission of nickel and molybdenum. A. R. SHUL'MAN AND E. I. MYAKININ. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 5, 1075–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-177.

Measurements with low-energy primary electrons ($eVp \sim 10$ eV) indicate the existence of a minimum energy required to cause secondary emission. This minimum energy corresponds to the work function $e\phi$ of the surface and a threshold relation $eVp \geqslant e\phi$ holds. C. G. MORGAN

537.533.8

5695. Physics and applications of secondary electron emission. H. BRUINING. *London: Pergamon Press* (1954) xii + 178 *pp.*

This book gives a survey of experimental and theoretical work on secondary emission from solids. The physical characteristics, methods of measurement and experimental data of emission from metals, metal compounds, semiconductors and insulators are reviewed and the influence of adsorbed atoms is discussed. The main features of the various theories of the mechanism of emission are treated and such topics as temperature dependence, current fluctuatio and energy distribution are included. Two chapt are devoted to practical applications where h emission is either desirable or to be suppressed. T last chapter is concerned with devices for the stora of information which makes use of secondary em sion. The 393 references are arranged in chronologi order. C. G. MORG

537.533.8 : 539.166.8

5696. Limits of applicability of the theory bremsstrahlung electrons and pair production for hi energies. L. LANDAU AND I. POMERANCHUK. *Do Akad. Nauk SSSR*, **92**, *No.* 3, 535–6 (1953) *In Russia* English translation, *U.S. National Sci. Found. NS tr*-136.

When considering radiation processes in a mediu as opposed to those occurring in a single isolat atom, the Bethe–Heitler formulae for bremsstrahlu and pair production are shown not to be valid in t high-energy region. G. FIEI

537.533

5697. A bibliography on Cherenkov radiatio including Cherenkov detectors and counters. J. TERRY. *Atomic Energy Res. Establ.* [*Harwell*] *In Bib.* 90, 10 *pp.* (1953).

537.533.9 : 534.222

5698. Čerenkov radiation and supersonic flow T. TANIUTI. *Progr. theor. Phys.*, **10**, 525–32 (*Nov* 1953).

The propagation character of light in a movin medium is investigated by an application of th characteristic theory of hyperbolic partial differenti equations with intimate connection with the theor of compressible fluids, and Cherenkov radiation then treated theoretically as a special case when th velocity of the medium exceeds the light velocity i the medium, analogously to shock waves such a result from supersonic flight of bullets through air. A

537.53

5699. A note on gaps at proton energies of 10 an 50 MeV in the proton linear accelerator. M. ROS AND W. WALKINSHAW. *Atomic Energy Res. Estab* [*Harwell*] *Mem. T/M*101, 4 *pp.* (1954).

For various reasons it will be necessary to leav gaps at intervals along the length of the 600 MeV proton linear accelerator. Because of phase oscilla tions the proton beam is not monoenergetic and there is therefore a tendency for the bunches to disperse in traversing these gaps. The present calculations make an estimate of the seriousness of this effect. A

537.534

5700. Acceleration of partially stripped heavy ions R. S. LIVINGSTON. *Nature* [*London*] **173**, 54–7 (*Jan.* 9 1954).

Details are given of the 63 in. cyclotron at Oak Ridge designed for the acceleration of triply-charged nitrogen ions. A special ion source has been designed using a high-current-density discharge at low pressure in a graphite chamber. With a d.c. accelerating potential, over 20 mA of N^{3+} ions have been obtained from a slit in the wall of the graphite chamber. More than 50 μA of 25 MeV N^{3+} ions have been obtained internally, and 1 μA in a deflected external beam.

hick target yields for 20 nuclear reactions have been found. The design of a 100 in. heavy-ion accelerator for production of new transuranic elements is discussed. J. H. FREMLIN

537.534

5701. On the importance of the defocusing caused by accelerating gaps in ion linear accelerators. M.-Y. BERNARD. *C.R. Acad. Sci.* [*Paris*] **238,** 675–7 (*Feb.* 8, 1954) *In French.*

It is shown that had the field in the gap been static it would have acted as a converging lens, but defocusing is caused by the increase of field during the transit. The latter effect is found predominant in a calculation using parameters appropriate to the Berkeley machine. J. S. BELL

537.534

5702. Space-charge forces in strong-focusing synchrotrons. S. E. BARDEN. *Phys. Rev.*, **93,** 1378–80 (*March* 15, 1954).

A new principle, strong focusing, has recently been put forward as the basis for the design of synchrotrons, particularly proton synchrotrons in the energy range above about 10 BeV. In this new proposal the field gradient index, n, is alternatively positive and negative and has a numerical value of some thousands as opposed to conventional, weak-focusing synchrotrons and betatrons, where $0 < n < 1$. The object of this note is to examine the effect of space-charge forces in strong-focusing synchrotrons on the stability of the radial and axial motion of the particles being accelerated. It is shown that, by virtue of the decrease of these forces as the particle velocity approaches that of light, the average field index is gradually altered throughout the cycle of acceleration. Such modulation, if sufficiently large, can make it impossible to provide radial and axial stability for the whole of this cycle. If the number of sectors, N, is much greater than 10, however, much smaller amounts of modulation may create conditions favourable for forced radial or axial resonances in the presence of inevitable magnet alignment errors, and it is this effect which places stringent limits on the strength of space charge forces permitted in a strong-focusing accelerator. The limitations discussed are far more serious in the case of proton beams than in the case of electron beams. A.

537.534.74

5703. Proton-proton scattering at high energies. P. BANERJEA. *Indian J. Phys.*, **27,** 557–61 (*Nov.*, 1953).

The differential cross-sections for proton-proton scattering are calculated in the Born's approximation using potentials consisting of the tensor operator multiplied respectively by $e^{-\lambda r}/\lambda r^2$ and $e^{-\lambda r}/\lambda^2 r^3$. Results for the second potential have been shown to give marked angular isotropy which agree qualitatively better with the experimental results of proton-proton scattering at 345 MeV energy than the existing calculations made with potentials derivable from field theories. A.

537.534.74

5704. Elastic scattering of intermediate-energy [14–42 MeV] alpha particles by gold. G. W. FARWELL AND H. E. WEGNER. Letter in *Phys. Rev.*, **93,** 356 (*Jan.* 15, 1954).

The energies ($27{\cdot}0 \pm 0{\cdot}3$ MeV and $20{\cdot}25 \pm 0{\cdot}4$ MeV) at which the elastic cross-sections (at $\theta_{lab} = 60°$ and 95°) were observed to begin to fall below the Rutherford scattering correspond to classical apsidal distances of $12{\cdot}5 \pm 0{\cdot}2$ and $12{\cdot}9 \pm 0{\cdot}3 \times 10^{-13}$ cm respectively. W. J. SWIATECKI

537.534.74

5705. Polarization of high energy protons scattered by nuclei. E. FERMI. *Nuovo Cimento*, **11,** 407–11 (*April*, 1954).

The attempt is made to explain the polarization recently observed in protons of several-hundred-MeV scattered by nuclei in terms of the same spin orbit coupling that is assumed in the nuclear shell model. It is found that the extrapolation to high energy of the spin-orbit coupling observed at low energy is adequate to yield the correct order of magnitude of the polarization. A.

537.534.74

5706. Elastic scattering of protons by nuclei. D. M. CHASE AND F. ROHRLICH. *Phys. Rev.*, **94,** 81–6 (*April* 1, 1954).

Exact calculations are carried out for the optical model in the 20 MeV region. A complex potential of spherical well shape is assumed in addition to the Coulomb potential. Results for the elastic scattering of protons by Al, Cu and Ag are compared with experiments. Though all relevant parameters are varied over large domains, no satisfactory agreement is obtained. Various possible alternatives are discussed. It is also shown that the "boundary condition model" offers a good approximation to the optical model within its range of validity. A.

537.534.74 : 539.185

5707. Phase-shift analysis of high-energy nucleon-nucleon scattering. R. M. THALER AND J. BENGSTON. Letter in *Phys. Rev.*, **93,** 643 (*Feb.* 1, 1954).

The proton-proton scattering data at 240 MeV and the neutron-proton at 260 MeV have been analysed in terms of s and p wave-phase shifts. P. T. MATTHEWS

537.534.8

5708. Note on secondary electron emission from metals bombarded by ions. J. SOMMERIA. Letter in *J. Phys. Radium*, **15,** 126 (*Feb.*, 1954) *In French.*

Secondary electron emission due to the impact of H^+ and H_2^+ ions in fields up to 100 kV/cm on Duralumin and copper was measured. These results and those of previous workers are compared and it is concluded that thin surface contaminating layers play an important part in the secondary emission process. C. G. MORGAN

537.534.8

5709. Electron ejection by slow positive ions incident on flashed and gas-covered metallic surfaces. J. H. PARKER, JR. *Phys. Rev.*, **93,** 1148–56 (*March* 15, 1954).

A direct measurement of the ejected electron yield (γ_i) for A^+ incident on flashed and H_2-, N_2- and O_2-treated Ta and Pt and for the singly-charged hydrogen, nitrogen and oxygen ions incident on Ta and Pt after treatment with the respective parent gas has been made for the kinetic energy range of 2 to

150 eV. The gas treatment for Pt consisted of an exposure to the molecular gas at a pressure of a few mm of Hg, while the treatment for Ta consisted of an exposure plus a glow discharge in which the Ta surface served as the cathode. In general, gas treatment of Ta and Pt was found to produce large decreases in γ_i for A^+ ions, with the effect increasing with decreasing ion energy. For both Ta and Pt the O_2 treatment was found to be the most effective in reducing γ_i while the H_2 treatment was found to be the least effective. γ_i for nitrogen ions on N_2-treated Ta and Pt showed a unique behaviour at low ion energy in that it was found to increase with decreasing ion energy. This behaviour was not observed for the other ions in this study. A.

537.534.8

5710. Liberation of electrons by positive-ion impact on the cathode of a pulsed Townsend discharge tube. R. N. VARNEY. *Phys. Rev.*, **93**, 1156–60 (*March* 15, 1954).

The parallel-plate Townsend discharge triggered by a flash of ultraviolet light on the cathode gives a current to the anode which depends strongly on the value of γ, the number of new electrons liberated from the cathode per positive-ion impact. An expression is derived relating γ to the first Townsend coefficient for ionization by electrons α and the anode-cathode separation X, which provides an easy experimental procedure for arriving at γ. Measurements are then given for γ as a function of E/p, the ratio of field strength to pressure, for Ne, A and Kr on a freshly cleaned Mo cathode. The values of γ are essentially independent of E/p above 175 volts/(cm × mm Hg) with values of 0·20 for Ne^+, 0·083 for A^+ and 0·053 for Kr^+. At lower values of E/p, γ decreases toward zero, but this decline is probably related to the back diffusion of electrons to the cathode and does not represent a decrease in the basic γ process. With A^+ ions and a nickel cathode coated with activated $BaCO_3$, the value of γ also levelled off at higher E/p at a γ value related to the degree of activation of the $BaCO_3$. Significantly, the value of γ for this surface did not tend toward zero at zero E/p. This may be attributed to a different distribution of electron velocities for the ejected electrons from the coated surface than for the pure surface. A.

537.534.9

5711. Momentum transfer in sputtering by ion bombardment. G. K. WEHNER. Letter in *J. appl. Phys.*, **25**, 270–1 (*Feb.*, 1954).

Examination of the distribution of the material sputtered from a metal sheet (immersed in a plasma of high density (10^{12} per cm^3) at low pressures ($<1\ \mu$)), on to a surrounding glass cylinder, leads to the conclusion that the sputtering depends on the angle of incidence of the ions, especially at low energies. The results support a momentum transfer theory of sputtering rather than an evaporation theory. J. DUTTON

537.534.9

5712. Threshold energies for sputtering and the sound velocity in metals. G. K. WEHNER. Letter in *Phys. Rev.*, **93**, 633–4 (*Feb.* 1, 1954).

The threshold energy for sputtering for perpendicular impact of Hg ions was measured for a number of metals, and the following relation was discover the product of the momentum transferred at thresh from the ion to the metal atom, with the bulk so velocity of the metal, is proportional to the heat sublimation. From the experimental results (hitherto unrecorded) sound velocity in boron deduced to be 14×10^5 cm/sec.

DISCHARGE TUBES . COUNTERS 537.54

537.5

5713. Studies on the ion source placed in a magne field. M. SAKISAKA, S. MIYASHIRO, Y. UEMURA A S. YASUMI. *Mem. Coll. Sci. Univ. Kyoto A*, **26**, 143– (*Oct.*, 1950).

A new type of ion source without a hot cathode constructed, which consumes little electric power gives a comparatively intense ion current. The d charge is produced in a small cylindrical space unc coaxial magnetic field. Between the iron cathod which constitute themselves a pair of magnetic po pieces an anode of doughnut shape is fixed. The io are generated by the agitative movement of electro in the electric and magnetic fields and then introduc into the higher vacuum side through a canal bored one of the cathodes. In the case of hydrogen ga it is operated adequately by the discharge voltage 1000∼2000 V d.c. under the magnetic field of 200 500 gauss at the vacuum pressure of 8×10^{-4}∼3 10^{-3} mm Hg, and the extracted ion current 20∼300 μA. The output ion current is easily co trolled by the adjustment of discharge voltag magnetic field or vacuum pressure. The ma analysis shows that more than 60% of total ions a protons. The comparison between the theoretic and experimental results for protons passing throug the canal is discussed and the most effective size canal is deduced. A gas leak apparatus to adjust th pressure range for proper operation is also devised A

537.54

5714. The focussing and magnetic analysis of beam from a radio-frequency ion source. A. N BANERJEE. *Indian J. Phys.*, **27**, 523–32 (*Oct.*, 1953).

The operation of a radio-frequency type of positiv ion source is described, in which the excitation wa produced by a 22 Mc/s, 200 W r.f. oscillator. Usin an extraction voltage of 2·2 kV, a total positive io current of 175 μA was delivered at the target. Th extraction-voltage beam-current characteristics sho that this current can be increased further to attain saturation value with increasing extraction voltage By suitably adjusting the ratio of the extractio voltage to the focusing voltage a 6–10 mm diamete beam could be obtained in the region of accelerato space. A magnetic analysis of the beam revealed tha its atomic ion content was more than 60%. A

537.54

5715. The production of ion beams from the plasma of gas discharges. O. REIFENSCHWEILER. *Ann. Phys* [*Leipzig*] **14**, *No.* 1–2, 33–53 (1954) *In German.*

Consideration of the "ion optics" of the probe

ystem used to extract ions from an h.f. discharge y Thonemann and others [Abstr. 4045 (1949)] ndicates that the ion current should be increased by ertain modifications in the design of the extracting ystem. This is confirmed experimentally using an I_2 discharge. The largest ion current obtained was mA for an h.f. power input of 260 W. It is shown hat the shape of the probe has little influence on the on current. Similarity laws for ion extraction ystems are given. J. DUTTON

537.542

5716. The delay in the build-up of halogen-quenched ounters. D. VAN ZOONEN. *Appl. sci. Res. B*, **3**, Vo. 4–5, 377–89 (1953).

It is shown experimentally that the so-called delay n halogen-quenched counters is only an apparent lelay. There is no real delay but only a very slow nultiplication giving the impression of a delay. The econdary mechanism is assumed to be ionization of halogen molecules by metastable rare gas atoms, the atter being formed by resonance radiation. The counters used were quenched with iodine and bromine. A.

537.542

5717. On large pulses in pure-vapour G.-M. counters. J. WESOŁOWSKI. *Acta phys. Polon.*, **12**, *No.* 1, 51–6 (1953).

Large pulses produced by α-particles in pure-vapour G.M. counters have been investigated in some detail. A typical operating characteristic is given of such a counter exposed to a divergent beam of α-radiation. A new luminous phenomenon associated with large pulses is described. A.

537.542

5718. On the temperature effect in Geiger Müller counters. C. P. JOSHI. *Indian J. Phys.*, **27**, 393–8 (*Aug.*, 1953).

The effect of temperature on the plateau characteristics of self-quenched and externally quenched counters was studied. Both types showed a deterioration of plateau from 20° to 60°c in spite of the fact that they were quenched externally for 10^{-3} sec. The results have been explained on the hypothesis of the formation of long-lived metastable 2^3P_0 states of Hg atoms. Traces of mercury vapour and free mercury are always present in counters due to the diffusion pumps, gauges, etc., connected to filling manifolds. These metastable states return to normal in 10^{-2} sec and trigger a spurious discharge in doing so. The effect was more pronounced in argon-hydrogen counters than in argon-ether self-quenched counters. A.

537.542

5719. The application of Wilkinson's theory to external-cathode Geiger-Müller counters. D. BLANC AND H. ZYNGIER. *J. Phys. Radium*, **15**, *Suppl. No.* 1, 1 A–4 A (*Jan.*, 1954) *In French.*

Gives detailed measurements of the charge per pulse as a function of counter voltage and counting rate for external cathode counters filled with argon-alcohol vapour. The results are in close agreement with predictions from the Wilkinson theory. J. D CRAGGS

537.542

5720. The behaviour of external-cathode counters, filled with pure methylal, under γ-ray irradiation. D. BLANC. *C.R. Acad. Sci.* [*Paris*] **238**, 673–5 (*Feb.* 8, 1954) *In French.*

Presents data for various filling pressures, etc. Values of plateau length, efficiency, etc., are given.

537.542

5721. Operating characteristics of external-cathode counters filled with pure methylal. D. BLANC. *Nuovo Cimento*, **11**, 231–40 (*March*, 1954) *In French.*

A detailed paper on the construction and operation of Maze-type counters filled with $CH_2(O\,CH_3)_2$. Irradiation was with γ-rays. The influence of tube geometry was investigated and the voltage characteristics are given graphically, with counting efficiencies. The final section discusses non-linearity observed with strong irradiation. J. D. CRAGGS

537.542 : 537.525.3

5722. Dynamics of corona discharge between cylindrical electrodes. L. COLLI, U. FACCHINI, E. GATTI AND A. PERSANO. *J. appl. Phys.*, **25**, 429–35 (*April*, 1954).

The qualitative explanation by Loeb of the constancy of the amplification factor with increasing corona currents with coaxial cylindrical electrodes used as in conventional Geiger counters, is placed on a quantitative basis. As anticipated, it is shown that it is the screening action of the space charge which is responsible for the constancy and the stability of the average discharge current. The fluctuations superposed on the constant current, previously reported, are explained as a response of the system having a definite resonance frequency to the statistical fluctuations of the photoelectric current. The theoretical predictions are confirmed by experimental data. A.

537.542

5723. On the use of $CO_2 + CS_2$ filled G.M. counters for age determination. W. MOŚCICKI. *Acta phys. Polon.*, **12**, *No.* 3–4, 238–40 (1953).

537.542 : 541.183.26

5724. A low-pressure counter for measurements of gaseous adsorption on solids. J. A. DILLON, JR AND H. E. FARNSWORTH. Note in *Rev. sci. Instrum.*, **25**, 96 (*Jan.*, 1954).

A mica-window counter placed inside the vacuum vessel is used for measuring adsorption of $C^{14}O_2$ on single metal crystals. Freon + argon filling is used and the overall efficiency for C^{14} is 7%. F. T. FARMER

537.542

5725. A sealed-off metal proportional counter for cosmic-ray work. J. S. BUCHANAN. *J. sci. Instrum.*, **31**, 136–7 (*April*, 1954).

In an attempt to increase the efficiency of penetrating shower selection systems used to trigger cloud chambers, a proportional counter of rectangular cross-section has been designed. The construction of the counter is described and a brief summary of its performance given. A.

537.542 : 537.531

5726. Absolute dosage measurement in the soft and very soft X-ray region by means of a total absorption ionization chamber. E. Bunde, D. Lang, W. Pohlit and A. Sewkor. *Z. Naturforsch.*, **9a**, 129–34 (*Feb.*, 1954) *In German.*

The chamber, described by diagram and photograph, has an air path-length of 2 m, sufficient to absorb totally X-radiation of energy up to 9 kV. Its response to 6–8 kV X-rays is compared experimentally with that of a standard air chamber. The set up is described, results are given and discussed. D. V. MABBS

537.542

5727. Afterpulses in scintillation counters. K. P. Meyer and A. Maier. *Helv. phys. Acta*, **27**, *No.* 1, 57–66 (1954) *In German.*

Afterpulses arising in scintillation counters built up of commonly used components are described. They may simulate delayed nuclear radiation, when using dead-time free coincidence arrangements. One source of afterpulses is the luminescence of dynode surfaces. Ag–Mg dynodes give afterpulses, Cu–Be practically none. Another source is the scintillator itself. The scintillations of anthracene and trans-stilbene crystals include slower components of remarkable intensity. Decay times (10^{-8} to 10^{-6} sec range) and intensities (3 to 10%) are given. These slower emissions are resolved by the multiplier into single-photon afterpulses. As expected for a liquid scintillator there are practically no afterpulses in a terphenyl solution. All afterpulses reported here are single-photon pulses. Using Schaetti multipliers 40 afterpulses arising from more than one photoelectron could be observed. A.

537.542

5728. Gamma-ray scintillation counter for weak radioactive solutions. C. P. Haigh. *Nucleonics*, **12**, 34–9 (*Jan.*, 1954).

The counter is designed to take liquid samples up to 10 cm^3 in volume in an annular polyethylene container surrounding a Na(Tl) phosphor. The dependence of the optimum condition of sensitivity and signal to noise ratio upon total photo-multiplier dynode voltage and discriminator voltage is discussed. Results of measurements, comparing the sensitivities of this counter and that of a jacketed thin-walled β-counter for I^{131} and Fe^{59}, show that the γ-counter is superior in performance. L. R. SHEPHERD

537.542 : 539.166.08

5729. On the use of the scintillation counter as a gamma ray spectrometer, using stilbene crystal. S. Dhar and S. K. Sen. *Indian J. Phys.*, **27**, 483–90 (*Oct.*, 1953).

A preliminary investigation, using the organic crystal stilbene and the 1P28 photomultiplier tube. Pulse height distribution curves have been obtained for the Co^{60} source with a thin lead radiator and a thin aluminium foil respectively. Co^{60} emits two γ-rays of energies 1·17 and 1·33 MeV; an attempt has been made to explain the formation of the peaks in the distribution curves in the light of the different processes through which γ-rays lose energy in the crystal material; the positions of the peaks agree well with the positions expected from theoretical considerations. The electronic circuits and the experimental arrangements are described in detail. A.

537.542 : 539.185.

A high-sensitivity fast neutron survey meter. *Abstr.* 6018

537.542 : 616–073.75 : 621.387.4

5730. A multiple scintillation counter *in vi* scanner. H. O. Anger. *Amer. J. Roentgenol.*, 7 605–12 (*Oct.*, 1953).

Ten collimated scintillation counters scanning strip 7 in. wide, are used. These are connecte through a 10-channel amplifier to 10 argon glo lamps, each γ-ray counted producing a flash of lig in the corresponding lamp. The glow lamp assemb is also synchronized to scan a photographic fil which records each light flash, so that concentratio of dots in the print indicate activity. The prese detection limit is 1 μC I^{131} spread over a 1 in. diamet circle at 2 in. distance. Circuits and layout a described. Prints of test scans and of a head-to-t scan (taking 45 min) of a patient with thyroid carc noma, using I^{131}, are shown. D. V. MAB

537.54

5731. Remarks on spark counters. G. Guében an M. Legros. *Bull. Soc. Roy. Sci. Liège*, **22**, 514–1 (*Dec.*, 1953) *In French.*

537.54

5732. Quenching unit for CO_2-filled G.M. counter S. Gorgolewski. *Acta phys. Polon.*, **12**, *No.* 152–5 (1953).

A new quenching circuit coupled with a high frequency high-voltage generator has been constructe and tested. The discharge pulse of the G.M. counte is fed to a univibrator generating a square pulse c adjustable length. The square pulse goes to a modu lator which lowers the amplitude of the radiofrequenc oscillations and thus the output voltage on the G.M counter.

537.542 : 539.16.0

5733. On the automatic determination of a statistica distribution of time intervals (with reference to th α-particle emission of Po). R. Chéry. *J. Phys Radium*, **15**, 72–82 (*Feb.*, 1954) *In French.*

The basic apparatus consists of a c.r.t. in which th deflection is proportional to the time interval betwee consecutive pulses; the distribution-in-time-intervals i then obtained by photographing the screen. Refine ments are described which enable the measurement o relatively small time intervals and of the distributio of time intervals following those of any selected length (no results of measurements on radioactive decay are given). A. O. STANESBY

537.542 : 621.317.7

5734. An ion current integrator. R. Littauer *Rev. sci. Instrum.*, **25**, 148–52 (*Feb.*, 1954).

An electronic integrator suitable for measuring ionization currents down to 10^{-11} A is described. The instrument simultaneously displays both the instantaneous value of the current and the total charge received. Automatic recycling is achieved with the aid of a contact mounted on the movement of a standard meter. Substantial lengths of coaxial cable with standard connectors may be connected to the input without producing unduly large leakage currents or changing the calibration, so that remote operation of the integrator is feasible. A.

537.542 : 621.374.32

5735. A simple pulse amplitude analyser for low counting rates. K. KANDIAH. *Trans Instrum. Meas. Conf.*, **1952**, 126–30.

Detailed electronic circuits are described for an electro-mechanical pulse amplitude analyser, designed to accept pulses from 0·5 up to 10 V. After 6× amplification a condenser is charged to the peak voltage of the pulse through a diode. A fraction of the voltage across the condenser is applied to the input of a high-speed self-balancing potentiometric recorder. The pen-driving mechanism of the recorder is mechanically coupled to a 20-segment switch defining the 20 channels. Each segment of the switch is connected to a mechanical register. Pulses are counted in the channel selected by the switch by connecting the supply voltage to the register when the pen is stationary. The condenser is then discharged and the system is ready to accept another pulse. It is arranged that the recorder pen does not return to zero between pulses but remains in the position corresponding to the peak of the last pulse received. In this way a time resolution of 1 second is achieved for pulses lying in a narrow band. Input circuits consisting of an ionization chamber and vibrating reed electrometer are described. Sources of noise are discussed and specimen results obtained with a polonium source are shown. D. R. CHICK

537.542 : 621.374.32

5736. Fast-coincidence circuit for H^3 and C^{14} measurements. R. D. HIEBERT AND R. J. WATTS. *Nucleonics*, **11**, 38–41 (*Dec.*, 1953).

A scintillator is viewed by two photomultipliers in coincidence. The overall rise time of the amplifiers used is 0·08 μsec and a resolving time as low as 0·05 μsec can be obtained. An "umbrella" of G.M. counters is set in anticoincidence with the coincidence output from the photomultiplier. Details of pre-amplifiers, main amplifiers, discriminators and coincidence-anticoincidence circuits are described.

L. R. SHEPHERD

537.543 : 621.3.014.1 : 621.385.2

5737. A study of current fluctuations in a planar diode, including the effect of space charge and transit time, on the basis of a multivelocity model. A. PÉREZ. *Czech. J. Phys.*, **1**, *No.* 2, 49–64 (1952) *In French.*

The insufficiencies of the model which replaces the real beam with one having an initial velocity equal to the mean initial velocity of the real beam are noted. A new model in which the convection currents due to the various groups of electrons of different velocities propagate along the beam without disturbing the mean state of the distribution is discussed. Results for the planar diode are obtained and are generally similar to those of North, in spite of the fact that the approximations necessary to carry out the calculations improve with increasing frequency. The present results predict somewhat higher noise currents than do North's figures. A. H. W. BECK

537.543 : 621.38

5738. The noise of valves. C. S. BULL. *Brit. J. appl. Phys.*, **5**, 127–32 (*April*, 1954).

It is shown that a diode valve displays, in addition to the well-known fluctuations in the anode current, independent fluctuations of its characteristics. As a consequence it has become possible to make a less restricted attack on the theory of the fluctuations than has hitherto been done. The new theory is analogous to the application of statistical mechanics to systems which are in thermal equilibrium, but it makes no use of the theorems of thermodynamics. The expressions used take proper account of the fact that the valve is not in thermal equilibrium, and also of the very strong mutual interaction between electrons, which is a major feature of the operation of the valve. The resulting equations are valid from the lowest to high anode currents. They are in such a form that the fluctuations can be calculated from the valve characteristic without a knowledge of the cathode temperature, Boltzmann's constant or the separation between the electrodes. It is therefore readily possible to compare the theoretically calculated value of the fluctuations with the observed values, and the extent of the agreement is demonstrated for particular cases. The effects of screen grids and secondary electron multiplication are calculated by a new approximate method. A.

IONIZATION . THERMIONICS 537.56/.58

537.56 : 537.591.8

Analysis of the ionizing power of relativistic particles. *See Abstr.* 5781

537.56 : 539.164

5739. Ionization of pure gases and mixtures of gases by 5-MeV alpha particles. T. E. BORTNER AND G. S. HURST. *Phys. Rev.*, **93**, 1236–41 (*March* 15, 1954).

In this experiment the charge produced in a large ionization chamber, by the complete stopping of Pu^{239} α particles, was measured using an accurately calibrated capacitor in series with a potentiometer. An electrometer connected across both the capacitor and potentiometer was used as a null indicator. From the charge produced the number of ion pairs n was deduced and W, defined by the equation $W = E/n$ where E is the energy used in forming the n ion pairs, was computed. For pure gases, the following values of W (in eV per ion pair) were found: A, 26·4 ± 3; BF_3, 36·0 ± 0·4; C_4H_{10}, 26·4 ± 0·3; CO_2, 34·3 ± 0·3; C_2H_4, 28·0 ± 0·3; He, 46·0 ± 0·5; H_2, 37·0 ± 0·4; CH_4, 29·4 ± 0·3; N_2, 36·3 ± 0·4; O_2, 32·2 ± 0·3; SF_6, 35·7 ± 0·4; air 35·0 ± 0·3; freon 12, 29·5 ± 0·3. Results for W for a mixture of gases are described by the formula $1/W_m = (1/W_1 - 1/W_2)z + 1/W_2$, where $z = P_1/(P_1 + aP_2)$, and W_m is the W for the gas mixture having two components of pressure P_1 and P_2 with W values for the pure gases equal to W_1, and W_2 respectively. For the following mixture a has the values shown: $N_2 - H_2$, 0·28; $N_2 - A$, 0·53; $N_2 - O_2$, 1·06; He — A, 0·75; He — H_2, 3·55; He — N_2, 8·47; He — CH_4, 0·68; A — H_2, 0·56; $H_2 - CH_4$, 4·03. In the case of He the W of 46·0 is not used in the above equation, since small traces of impurities reduce W(He) to 30·0 eV, and this latter value is appropriate for using in the formula for gas mixtures. A.

537.564

5740. The ionization maintained in a gas before a thin plane uniform circular source of ionizing particles. P. A. FRASER. *Amer. J. Phys.*, **22**, 220–3 (*April*, 1954).

An expression is derived that gives a good representation of the volume rate of production of ion pairs in a gas before a thin plane circular uniform source of ionizing particles. The expression is valid when the radius of the source disk is restricted to be less than one quarter of the range at maximum ionization of the particles. This is not a severe restriction for practical cases. Curves and a table of this rate are given, in which distances are in units of the radius of the source disk, and hence are of general applicability within the restriction on the source disk radius. This work has application to a number of fields, among them the study of the optical radiation from the region in front of such a source. A.

537.564 : 537.534.9

5741. Fast negative hydrogen ions. A. C. WHITTIER. *Canad. J. Phys.*, **32**, 275–90 (*April*, 1954).

A proton beam was directed through hydrogen gas at low pressure and magnetic analysis of the emergent beam showed that an appreciable fraction of the beam was transformed into negative hydrogen ions. After the beam had traversed a sufficient layer of gas, the ratio of negative hydrogen ions to protons reached an equilibrium value which was a maximum of 22·2% at 8·5 keV. The proton energy interval investigated extended from 4 to 70 keV. In this interval the electron loss cross-section for negative hydrogen ions was measured and found to vary from $6{\cdot}3\times10^{-16}$ cm² at 4·2 keV to $2{\cdot}5\times10^{-16}$ cm² at 70·3 keV. The electron capture cross-section for protons in hydrogen was measured over the same interval and the results agreed substantially with those of other workers. The electron capture cross-section for neutral atoms was also determined by combining present results for the negative ion loss cross-section and for the equilibrium ratio of H^- to H^+ with the values of Bartels and of Montague and Ribe for the ratio of neutral atom loss cross-section to the proton capture cross-section. A.

537.581

5742. On a new method of determining the thermionic constants of molybdenum. I. S. B. L. MATHUR. *Proc. Nat. Inst. Sci. India*, **19**, 153–63 (*March–April*, 1953).

By measuring the electronic current effusing out of a small hole in an otherwise closed cylinder of molybdenum, heated to various high temperatures in a graphite furnace tube worked in vacuum, the electronic work function of molybdenum was found to be 4·23 eV in good agreement with some of the recent determinations by other methods. The value of the constant A, which was not in similar good agreement with the values found by other investigators, was found to be 241 A cm^{-2} deg^{-2}. The merits of this newly developed method are discussed. A.

537.581

5743. The thermionic work function of iron. II. S. B. L. MATHUR. *Proc. Nat. Inst. Sci. India*, **19**, 165–8 (*March–April*, 1953).

From the rate of effusion of electrons from a small hole in an otherwise closed cylinder of iron heated in vacuum to different high temperatures the thermionic work function of iron was found to be 4·76 eV, wh the value of the constant A_0 was found to be 7 A cm^{-2} deg.$^{-2}$ between 1370°c and 1490°c. No pa ticular effect of transition from the δ- to the γ-fo of iron was noticeable. This was probably due to t comparatively quick changes in temperature duri the investigations which did not allow any form iron to become stable.

537.5

5744. The thermionic work function of graphite. II S. B. L. MATHUR. *Proc. Nat. Inst. Sci. India*, 169–71 (*March–April*, 1953).

See preceding abstract. The value of the electr work function for graphite was found to be 4·83 and that of the constant A_0 was 170 A cm^{-2}deg^{-2}.

537.5

5745. On the theory of the work function of meta W. OLDEKOP AND F. SAUTER. *Z. Phys.*, **136**, *No.* 534–46 (1954) *In German.*

The Thomas–Fermi method is used to investiga the polarizing effect of a metal electron upon t distribution of the remaining conduction electron For the alkali metals it is found that the influence o the work function of this image force effect pr dominates over that of the electrostatic double lay at the surface of the metal. E. H. SONDHEIM

537.583 : 621.385.1.032.2

5746. Thermionic properties of thoria layers thoriated molybdenum. G. MESNARD. *Vide*, 1377–83 (*July–Sept.*, 1953) *In French.*

The thorium liberated from the support wire pr duces a small increase in the free thorium in th coating. No practical gain results as the thoriate Mo is not reduced at the operating temperatu (~ 2000°K) of thoria cathodes. A. H. W. BEC

COSMIC RAYS 537.591

537.59

5747. Recent researches on cosmic radiation in th Soviet Union. G. WATAGHIN. *Nuovo Cimento*, 10 *Suppl. No.* 4, 489–508 (1953).

Individual summaries, some of them with diagram and graphs, are given of the 16 papers presented at conference held in June, 1952, and published in *Izv Akad. Nauk SSSR* (*Ser. Fiz.*) **17**, *No.* 1 (1953). Th titles are treated individually in Abstr. 5237, 5748–50 5755–6, 5764–6, 5768, 5770–4, 5781. [Note: A different transliteration scheme is used for th authors' names in Wataghin's article.]

537.59

5748. Summary of communications presented at th June 1952 meeting on cosmic rays; introductory re marks. D. V. SKOBEL'TSYN. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17**, *No.* 1, 9–12 (1953) *In Russian.*

See Abstr. 5747 (1954).

537.591.1

5749. Nature and properties of the primary cosmic radiation. S. N. VERNOV, A. M. KULIKOV AN A. N. CHARAKHCH'YAN. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17**, *No.* 1, 13–20 (1953) *In Russian.*

The penetrating component and the nucleon-

ctron showers of the cosmic radiation were in-tigated at balloon altitudes at three latitudes °, 31°, 2°) using counter hodoscope sets. Curves given showing the variation of frequency with itude and it is concluded that the collision cross-tion, for protons of 5×10^9 eV in lead is approxi-tely geometrical. [Shortened version of Wata-in's summary (see Abstr. 5747 above) which con-ns 7 diagrams.] H. ELLIOT

537.591.1

50. Spectrum and interaction with matter of otons in cosmic radiation. A. T. DADAYAN AND I. MERZON. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17**, o. 1, 72–9 (1953) *In Russian.*

The experiments were performed at 3200 m altitude, ing a magnetic spectrograph with a 76 ton electro-agnet (pole-pieces 100×30 cm, gap 12 cm, max. ld 19 000 Oe). Trajectories were determined by five ts of counters with axis parallel, and five normal, to e field. Each set contained 49 counters (dia. 6 mm, length 105 mm, Al wall 0·1 mm thick) liagram in Wataghin's summary (see Abstr. 5747 ove) which also gives curves of the spectrum of articles produced in lead, and the spectrum of rotons produced in lead]. The spectra can be well presented by a power law with exponents of the rder of 2·8 and 3·8 for two of the curves of particles roduced in lead, and 2·8 for the high-energy protons, n agreement with the results of Mylroi and Wilson Abstr. 5518 (1951)]. [Transcription of Wataghin's ummary.]

537.591.1

751. Photo-electric determination of the charge of eavy primaries in the cosmic radiation. B. WALDE-KOG. *Ark. Fys.*, **7**, *Paper* 40, 475–85 (1954).

The method depends on measuring photoelectric-lly the mean trackwidths of tracks ending in a photo-raphic emulsion. It is shown that the particles are asily divided into groups representing different values f the charge even if a track length of only 300 μ is sed. No definitely primary particles with charge $Z = 3$, 4 or 5 have been found. The possibility of inding such particles in the plate packet is discussed. The statistical material available is not enough to lecide whether particles with charge 3, 4 or 5 are resent in the primary radiation or not. A.

537.591.1

5752. The spread of the soft component of cosmic adiation. G. MOLIÈRE. Letter in *Phys. Rev.*, **93**, 636 *Feb.* 1, 1954).

Replies to criticism by Green and Messel [Abstr. 304 (1953)] of previous work on this subject.

H. ELLIOT

537.591.1

5753. A Čerenkov counter–cloud chamber measure-ment of multiply-charged primary cosmic rays. J. LINSLEY. Letter in *Phys. Rev.*, **93**, 899 (*Feb.* 15, 1954).

The flux of fast particles with $z \geqslant 2$ has been measured at balloon altitude by means of a cloud chamber containing five $\frac{1}{4}$ in. Cu plates and triggered by a Cherenkov counter. The flux of He nuclei was found to be $160 \pm 27/m^2.sec.$ ster. and for nuclei with $z > 2$, $23 \pm 6/m^2.sec.$ ster. Excluding the possi-bility of a statistical fluctuation, the large value of the flux for $z > 2$ implies that primary nuclei with $3 \leqslant z \leqslant 5$ exist in comparable abundance to heavier nuclei. H. ELLIOT

537.591.1

5754. Cosmic-ray protons at 3·4 kilometers. C. E. MILLER, J. E. HENDERSON, G. R. GARRISON, D. S. POTTER, W. M. SANDSTROM AND J. TODD, JR. *Phys. Rev.*, **94**, 167–73 (*April* 1, 1954).

A magnetic cloud chamber and an appropriate arrangement of coincidence and anticoincidence Geiger counters were used to photograph tracks of charged particles with ranges of 0·4 to 15 cm and 0·4 to 30 cm of lead. The momentum intervals corresponding to these range intervals are sufficiently different for protons and mesons for a large momentum interval to have resulted in which only protons were stopped due to ionization losses. At higher momenta, most of the protons were stopped by nuclear interaction because of the large thicknesses of absorber used. At lower momenta, where both protons and mesons were stopped, the protons were distinguished by track density. The result is an accurate proton momentum spectrum for the interval 0·7 to 2·0 BeV/c, in which it is found that protons form $20 \pm 2\%$ of all ionizing nonelectronic particles. From the number of protons stopped in 15 and 30 cm of lead the path length for removal of protons in lead by nuclear interaction is calculated to be 206 ± 30 g/cm^2 in the momentum interval 0·9 to 2·5 BeV/c.

A.

537.591.1 : 523.852

Magneto-hydrodynamic processes in nebulae as cause of cosmic rays. *See Abstr.* 5237

537.591.15

5755. Nucleon interactions at high energies and extensive showers. G. T. ZATSEPIN, I. L. ROZENTAL', L. I. SARÝCHEVA, G. B. KHRISTIANSEN AND L. H. ÉĬDUS. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17**, *No.* 1, 39–50 (1953) *In Russian.*

Summarizes the results of measurements on extensive air showers at 3860 m altitude. It is found that the particle density at a distance r from the shower core varies as r^{-n} where $2{\cdot}7 < n < 3{\cdot}1$, for $200 < r < 600$ m. The fraction of penetrating particles increases with r and reaches 25% at $r \sim 600$ m. It is concluded that the integral energy spectrum of the primary radiation can be expressed as a power law with exponent between 1·6 and 1·8 for energies up to 10^{18} eV. See also Abstr. 8297 (1952). [Shortened version of Wataghin's summary (see Abstr. 5747 above) which contains 6 diagrams.] H. ELLIOT

537.591.15

5756. On the theory of nucleonic cascades and extensive showers. I. L. ROZENTAL'. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17**, *No.* 1, 65–71 (1953) *In Russian.*

The theory given assumes multiple production in the collision of energetic nucleons; it also assumes that the interaction mean free path for energetic nucleons $\simeq$ the geometrical one (the value used is ~ 80 g/cm^2 in air) and that the cross-section of mesons with nuclei is also geometrical. The diffusion equations are written down and solved. Comparison with experiments indicates that the multiplicity increases with the energy of the primary particles, as

$n \sim E^{\gamma}$, where $\gamma \simeq \frac{1}{2}$ (as in Fermi's theory). It is concluded that this theory also gives a satisfactory description of the observed spatial distribution of particles in extensive showers [Abstr. 5555 (1953)]. [Transcription of Wataghin's summary (see Abstr. 5747 above).]

537.591.15

5757. Cloud-chamber investigation of the production of penetrating showers in aluminium and lead. R. L. Sen Gupta, K. K. Roy and M. M. Biswas. *Z. Phys.*, **136,** *No.* 5, 654–8 (1954) *In German.*

The size frequency distribution of locally produced penetrating showers under Al and Pb at sea level was investigated. The experimental results are in agreement with the plural theory of meson production suggested by Heisenberg. J. HUGHES

537.591.15

5758. Structure of air showers. W. E. Hazen, R. W. Williams and C. A. Randall, Jr. *Phys. Rev.*, **93,** 578–85 (*Feb.* 1, 1954).

Cosmic-ray air showers of total energy in the range 10^{14} to 10^{15} eV have been studied at 3260 m elevation with a large multiplate cloud chamber in combination with five thin-walled ionization chambers. The spatial distribution of electrons near the shower axis is usually a smooth function of distance with a singularity less marked than $1/r$. Evidence is presented, however, to show that some showers have a lumpy structure near the axis. The showers are very poor in high-energy electrons and photons near the axis, relative to the expectation for a single electron-photon cascade. The angular distributions of shower axes are found for various shower sizes and prove to be quite similar to those expected for single electron-photon cascades. The implications for various shower models are discussed and a fairly extensive nucleonic cascade is indicated. A.

537.591.15

5759. Influence of the Earth's magnetic field on the extensive air showers. G. Cocconi. Letter in *Phys. Rev.*, **93,** 646–7 (*Feb.* 1, 1954).

This note points out in a qualitative manner that the magnetic displacement of the electrons ($\pm$) of a shower from the rectilinear path may be not negligible in comparison with the displacement due to Coulomb scattering.

537.591.15

5760. Density of extensive air showers at airplane altitudes. H. L. Kraybill. *Phys. Rev.*, **93,** 1360–1 (*March* 15, 1954).

The exponent γ in the density spectrum of extensive air showers has been measured at 25 000 ft, 30 000 ft, and 33 000 ft pressure altitude, by observing the threefold coincidence rate of counter trays as a function of tray area. Areas of the individual trays were varied by factors up to eight. The measured mean values of γ are 1·45 at 25 000 ft, 1·5 at 30 000 ft, and 1·56 at 33 000 ft. A.

537.591.15

5761. The altitude and angular dependence of cosmic-ray air showers. H. L. Kraybill. *Phys. Rev.*, **93,** 1362–6 (*March* 15, 1954).

The angular distribution of the axes of large air showers incident upon a typical coincidence counter detector has been computed in detail from the altitu dependence. The distribution may be approxima by the function $\cos^{5\cdot5}\theta$ at 3500 m elevation and $\cos^{7\cdot5}\theta$ at sea level. These distributions have b tested experimentally by comparing the rates of h zontally and vertically oriented counters. vertical-horizontal counting ratio (R) was measu to be $2\cdot12 \pm 0\cdot07$ at 3500 m, and $2\cdot68 \pm 0\cdot07$ sea level. Values of R calculated from the ab angular distributions are somewhat higher. difference is attributed principally to scattering shower particles about the primary axis.

537.591

5762. Air-shower transition in water; interpretat of under-water decoherence curves. W. E. Haz *Nuovo Cimento*, **11,** 393–8 (*April*, 1954).

Under-water decoherence curves taken w ionization chambers by El Mofti [Abstr. 1442 (195 are reinterpreted by means of a more detailed calcu tion. The observations require no core multiplic for interpretation but are consistent with the oc sional occurrence of multiple-cored showers with c separations $\lesssim$ 1 m. The rate versus depth in wa indicates a rather soft energy spectrum in air.

537.591.15 : 519.2

5763. Studies on the theory of cascades. L. Jánossy *Acta phys. Hungar.*, **2,** *No.* 4, 289–333 (1952).

This paper gives a generalized derivation of t *G*-equations which were given in a more special fo previously. It is also shown that many known resu of the cascade theory—including results concern with the lateral spread of showers—can be simp obtained from the generalized *G*-equations.

537.591

5764. On the energy spectrum of primary cosmic r particles. A. A. Logunov and Ya. P. Terletsk *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17,** *No.* 1, 119– (1953) *In Russian.*

The authors start from the assumption that prima particles are emitted from the stars, than accelerate by induced electric fields and finally further accelerate according to Fermi's mechanism in collision wi moving magnetic fields in the Galaxy. They propos to improve the results of Fermi's theory by treatin the equations for the "turbulent" motion of magnet fields more accurately. The integration of th equations, based on the assumption that the diffusio coefficient of the particle $\propto$ its energy, leads to a energy spectrum of primary particles of the form $f(E) \simeq \beta \,.\, E^{-2\cdot5} \exp(-\beta E/\alpha)$, in good agreemen with experimental results (the effect of the exponentia factor is negligible up to energies of $\sim 10^{20}$ eV) [Transcription of Wataghin's summary (see Abstr 5747 above).]

537.591.

5765. On the absorption and interaction of particle producing showers of nucleons and electrons. S. A Azimov, N. A. Dobrotin, A. L. Lyubimov and K. P. Ryzhkova. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17,** *No.* 1, 80–7 (1953) *In Russian.*

The interaction and absorption free paths for the shower-producing particles have been measured fo carbon, iron and lead using a hodoscoped counter set The values found for the absorption mean free paths

re 216 ± 15, 344 ± 25 and 482 ± 31 g.cm^{-2} pectively. These results are discussed and it is ncluded that they can only be explained by suming that some plural production of mesons kes place. [Shortened version of Wataghin's mmary (see Abstr. 5747 above) which contains diagram.] H. ELLIOT

537.591.3

5766. On the decay particles producing showers of icleons and electrons. S. A. AZIMOV AND V. F. ISHNEVSKIĬ. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17,** *No.* 1, 88–91 (1953) *In Russian.*

Transitions for showers generated in water, and sorption mean free paths in water and in air, ave been studied in a series of measurements at 00 m and 950 m. For the latter, the following sults were obtained: 223 ± 15 (water), $123 \pm$ g.cm^{-2} (air). The authors conclude that about ne-third of shower-producing secondary particles ecay in air (at average mountain altitudes). [Transiption of Wataghin's summary (see Abstr. 5747 bove).]

537.591.5

5767. Comparison of the frequency and density of osmic ray showers in Amsterdam at sea-level and in enya at 2880 m. J. CLAY AND J. STRACKEE. *Proc. K. Ned. Akad. Wetensch. B,* **55,** 613–19 (1952).

From the results of investigations on 3-fold and -fold coincidences in Amsterdam (sea-level) and at imboroa (2880 m) the density and the frequency of showers could be computed. With two telescopes of sets of counters each at varying distances the xtension of the showers and the total number of articles contained therein could be estimated. The ensity of particles in the showers as well as the otal number of particles of showers and the dimenion of the latter were found to be remarkably in greement at the two places, on the understanding hat the frequency was about ten times as large at imboroa. This may indicate that the processes are dentical at the two places. A.

537.591.5

5768. Variation of the meson component intensity during a cycle of solar activity. E. S. GLOKOVA. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17,** *No.* 1, 136–40 (1953) *In Russian.*

Examination of the published records of continuous observations of cosmic-ray intensity in 1937–46, particularly Huancayo and Cheltenham. The increase of the meson component intensity corresponding to an average decrease of solar activity is discussed in detail. [Transcription of Wataghin's summary (see Abstr. 5747 above).]

537.591.5

5769. Fine structure in the directional intensity of cosmic rays at Hyderabad. D. S. R. MURTY. *Proc. Indian Acad. Sci. A,* **38,** 516–21 (*Dec.*, 1953).

Fine structure measurements were taken at Hyderabad ($\lambda = 7 \cdot 7°$N) in both the east and west azimuths. Two triple coincidence telescopes making angles of 9° 38′ and 5° 18′ in the zenith, in the eastern azimuth and western azimuth respectively were employed. The observations were taken in steps of 5° from the vertical up to 45°. The results show the existence of fine structure for the first time at such a low geomagnetic latitude as 7·7°N. A.

537.591.5 : 537.533.3

Experimental determination of electron orbits in the field of a magnetic dipole. *See Abstr.* 5670

537.591.8

5770. Interaction of primary particles of different energies with matter. N. L. GRIGOROV AND V. S. MURZIN. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17,** *No.* 1, 21–38 (1953) *In Russian.*

The production of electron-nucleon showers was investigated as a function of height at latitudes 51° and 31° using counters and ionization chambers. The data so obtained are used to deduce the fraction of the energy spent by the primary particles in generating the different components of the secondary cosmic ray flux. [Shortened version of Wataghin's summary (see Abstr. 5747 above) which contains 5 diagrams and 2 tables.] H. ELLIOT

537.591.8

5771. On the multiple production of particles in high energy collisions. L. D. LANDAU. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17,** *No.* 1, 51–64 (1953) *In Russian.*

The author considers a modified version of Fermi's theory of meson production and calculates the angular distribution and energy spectrum of the created particles. [Shortened version of Wataghin's summary (see Abstr. 5747 above) which contains 1 diagram.] H. ELLIOT

537.591.8

5772. Protons and mesons produced by cosmic-ray mesons. M. I. DAĬON. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17,** *No.* 1, 92–3 (1953) *In Russian.*

The particles produced in a Pb screen 9 cm thick were studied at 3250 m. The author deduces, among other conclusions, that mainly negative mesons are produced in Pb by neutrons. [Transcription of Wataghin's summary (see Abstr. 5747 above), which contains a diagram of the apparatus used and a histogram of the results.]

537.591.8

5773. On fast deuterons in cosmic rays. A. I. ALIKHANYAN AND G. A. MARIKYAN. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17,** *No.* 1, 94 (1953) *In Russian.*

Two sets of measurements were made at 3200 m with the apparatus of Abstr. 5750 (1954), with magnetic fields of 6200 and 14 000 gauss respectively. A group of particles with mass in the range 3500–4000 (deuterons) was separated from the proton peak. The number of deuterons having a range of 3–6 cm in Pb (200–400 MeV) was about 10% of the protons with equal range. At least 25% of the deuterons recorded were produced in Pb by incident neutrons. An approximate evaluation of the production cross-section, for neutrons having $E > 500$ MeV, gives $\sigma \simeq 0 \cdot 26\ \sigma_0$, where σ_0 is the geometrical cross-section of a Pb nucleus. [Transcription of Wataghin's summary (see Abstr. 5747 above).]

537.591.8

5774. New elementary particles in the cosmic radiation. G. B. ZHDANOV. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17,** *No.* 1, 95–101 (1953) *In Russian.*

Detailed report of work done outside the U.S.S.R. The author mentions some recent results of

Alikhanyan and others with a new magnetic spectrometer, showing particles with masses put provisionally in the range 400–1400. [Transcription of Wataghin's summary (see Abstr. 5747 above) which contains a histogram of the provisional results.]

537.591.8

5775. Mass measurements of primaries of *S* events by a momentum-range method. W. B. Fretter, B. P. Gregory, R. Johnston, A. Lagarrigue, H. Meyer, F. Muller and C. Peyrou. Letter in *Phys. Rev.*, **92**, 1583–4 (*Dec.* 15, 1953).

Details are given of 7 *S* events (6 positively charged and 1 undetermined) observed in a multiplate cloud chamber at the Pic-du-Midi. Four of these events cannot be τ-mesons but could be κ- or χ-particles and have an average mass $922 \pm 40\, m_e$. No electron shower was observed in the direction opposite to the secondary particle in any of the events. H. ELLIOT

537.591.8

5776. Production of fast lithium, beryllium, boron fragments from interactions of primary cosmic-ray nuclei. J. H. Noon, M. F. Kaplon and D. M. Ritson. Letter in *Phys. Rev.*, **92**, 1585–6 (*Dec.* 15, 1953).

The production of the light elements, as fast fragments from nuclear interactions of heavy primaries in stripped emulsion, has been studied for primaries in the ranges $6 \leqslant Z \leqslant 10$ and $Z > 10$. The results are used to estimate the probability of production of light elements in the atmosphere and it is concluded that a large part of the flux of Li, Be and B at a depth of 24 g.cm^{-2} is secondary in origin. H. ELLIOT

537.591.8

5777. On the production of electronic component by fast μ-mesons. A. Lovati, A. Mura and C. Succi. Letter in *Nuovo Cimento*, **11**, 92–5 (*Jan.*, 1954).

The rate of production and angular distribution of knock-on electrons was investigated using a multiplate cloud-chamber operated under 55 m.w.e. of granite. The results obtained agree well with those of other workers. H. ELLIOT

537.591.8

5778. An analysis of cosmic ray jets. C. B. A. McCusker and F. C. Roesler. Letter in *Nuovo Cimento*, **11**, 98–9 (*Jan.*, 1954).

Comments on a paper by Dilworth *et al.* [Abstr. 2556 (1954)] which compared the results of experimental work on cosmic-ray jets with the theory of high-energy jets due to the present authors.

H. ELLIOT

537.591.8

5779. A cloud-chamber investigation of nuclear interactions of cosmic rays. N. R. Whetten, R. S. Preston, R. V. Adams, R. M. Walker and H. L. Kraybill. *Phys. Rev.*, **93**, 1356–60 (*March* 15, 1954).

A magnet cloud chamber recently constructed at Yale University was operated at mountain altitudes (Climax, Colorado, elev. 11 200 ft) during the late fall of 1952. The cloud chamber was electronically controlled to photograph penetrating shower events initiated by high-energy cosmic rays. Five examples of neutral *V*-particle decays have been observed. One photograph reveals the decay of two V_2^0 particles that probably originated in a single nuclear interaction. Secondary particles in the penetrating show have been examined for sign of charge. From positive-to-negative ratio of charge of the second particles, it has been determined that 30% of observed proton-plus-meson secondary particles protons. This percentage is a lower limit, but probably close to the actual value.

537.59

5780. Neutral-to-charge ratio in high-energy interactions. M. F. Kaplon, W. D. Walker and Koshiba. Letter in *Phys. Rev.*, **93**, 1424 (*March* 1954).

The ratio of the production of charged particles other than π-mesons to that of π-mesons is found to be $0{\cdot}09 \pm 0{\cdot}25$ for energies $\geqslant 10^{12}$ eV per nucleon from the study of the ratio of π^0 to charged particles produced in emulsions. The conclusion is reached after assuming charge independence and that π^0-mesons are the sole source of high-energy γ-rays.

G. E. BROW

537.591.8 : 537.

5781. Analysis of the ionizing power of relativistic particles. V. M. Kharitonov. *Izv. Akad. Nauk SSSR* (*Ser. Fiz.*) **17**, *No.* 1, 102–113 (1953) *In Russian*.

Report of measurements made with the apparatus of Abstr. 5750 (1954). The results are in good agreement with the well-known Landau formula [Abstr. (1947)] and show that for relativistic particles the ionization increases as a consequence of the density effect calculated by Fermi and Wick. [Transcription of Wataghin's summary (see Abstr. 5747 above).]

537.591.8 : 539.166.8

5782. Angle of divergence of pairs produced by photons. K. Hintermann. Letter in *Phys. Rev.*, 9 898 (*Feb.* 15, 1954).

The angular divergence and photon energy for 126 pairs produced by cosmic-ray photons in nuclear emulsions have been measured, the photon energy being deduced from scattering measurements on the electron tracks. The results are compared with theory and discussed in relation to energy estimation from the opening angle of the pair. H. ELLIO

537.591.8 : 539.1

5783. A *V*-decay event with a heavy negative secondary, and identification of the secondary *V*-decay event in a cascade. E. W. Cowan. *Phys. Rev.*, 94 161–6 (*April* 1, 1954).

Two cosmic-ray decay events have been photographed in a cloud chamber under conditions that yield mass values from combined magnetic-field momentum measurements and ionization measurements from droplet counting. A method has been developed for assigning meaningful probable errors to the ionization measurements. The first event is interpreted as the decay of a neutral *V*-particle into a positive π-meson and a negative particle of mass $1850 \pm 250 m_e$. On the assumption of a two-body decay, the *Q* value for the decay is $11{\cdot}7 \pm 4$ MeV. The second event is a cascade decay that can be summarized by the following reaction:

$$Y^- \rightarrow 67 \pm 12\,\text{MeV} + \pi^- + \Lambda^0$$
$$\searrow$$
$$40 \pm 13\,\text{MeV} + \pi^- + p$$

proton of the Λ_0 decay is identified by a measured

ass of 2050 ± 350m_e. On the assumption of a two-ody decay, the mass of the primary V-particle is 00 ± 34m_e. A.

MAGNETISM 538

538.082

784. The measurement of magnetic fields in scale odels with special reference to saturation effects. . LANGNER AND F. LENZ. *Optik*, **11**, *No.* 4, 171–80 954) *In German.*

A method of measuring very inhomogeneous fields n scale models is described. The magnetic conditions at the model must satisfy are given. For example, ne magnetization curve of the material of the model ust be geometrically similar to that of the original. he method has been applied to measure the field istribution in a projector lens with variable pole-iece spacing. Nickel was used in the model instead f the cobalt-iron alloy in the original. The possible rrors of the method are discussed.

A.E.I. RESEARCH LABORATORY

538.082 : 537.533.3

785. Electron-optical shadow method of magnetic-ield mapping. L. MARTON, J. A. SIMPSON AND S. H. ACHENBRUCH. *J. Res. Nat. Bur. Stand.*, **52**, 97–104 *Feb.*, 1954).

The essential features of the electron-optical hadow method for the quantitative mapping of nagnetic fields are presented in unified form. The rocesses of obtaining and analysing the shadowgrams re given in some detail. Iterative procedures of nalysis, which have proved successful in practice, re illustrated by the mapping of an otherwise naccessible ferromagnetic domain field. An analytical nethod, involving inversion of integral operators is escribed. The method, although it has not yet been pplied to the analysis of shadowgrams, is given ecause of its generality and applicability to the quivalent problem of interpretation of fluid dynamic nterferograms. A.

538.082 : 538.13

786. On the positions of the equivalent poles in a magnetized bar tested by the magnetometer method. H. MASUMOTO, G. ÔTOMO AND M. SUGIHARA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 329–34 (*Aug.*, 1953).

According as the two coils used in the magneto-meter method are in the same axis or in parallel, two equations showing the relations of the equivalent distance between two poles to the distance between the magnetometer and the magnetized bar were deduced, and using the values of free magnetism in a soft iron bar determined by T. Yoshida and H. Kadooka, the positions of the equivalent poles were calculated. It was found that the positions of the equivalent poles were remarkably influenced by the distance between the magnetometer and the magnetized bar, and by the intensity of external field. A.

538.082 : 550.38

5787. Note on a proposed three-component aero-magnetometer. V. B. GERARD. *New Zealand J. Sci. Technol. B*, **35**, 1–3 (*July*, 1953).

For observation by this instrument, flying is restricted to clear nights, and star photographs are taken by a non-magnetic camera mounted on the fluxgate gimbal mechanism of a total-force aero-magnetometer. The camera's optical axis is parallel to the total-force fluxgate, and, by identifying the stars photographed, the orientation of the total-force fluxgate is determined and the magnetic declination and dip calculated. Tests made on the ground, with an experimental camera, indicated that this proposed method is feasible, and that the expected error would be about ±0·2° in both declination and dip. A.

538.11

5788. On the theory of magnetic susceptibility of thin layers of metals at low temperatures. I. M. LIFSHITS AND A. M. KOSEVICH. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 4, 795–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-156.

The magnetic moment of a thin layer of metal in a magnetic field parallel to its plane is calculated [see also Abstr. 950, 8511 (1953)]. D. SHOENBERG

538.114

5789. A derivation of the Curie–Weiss and Weiss laws from Heisenberg's theory of ferromagnetism. L. VALENTA. *Czech. J. Phys.*, **3**, 188–92 (*Sept.*, 1953).

On a model of a ferromagnetic built up of hydrogen-type atoms with the two possible spin orientations of the electron a derivation of the law of Curie–Weiss is shown which can also be used for more general cases. At the same time a new derivation of the Weiss law is given for this model. A.

538.114

5790. On the collective electron model of ferro-magnetism. T. HIRONE AND S. MIYAHARA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4**, 369–75 (*Aug.*, 1952).

The spontaneous magnetization of the ferromagnetic substance was discussed on the basis of the collective electron model, the result of which was applicable to the case of an intrinsic semiconductor. Sudden disappearance of spontaneous magnetization in some kinds of ferromagnetic semiconductors was expected from the present theory. This result coincided with the experimental data on CrS by Haraldsen and Neuber. A.

538.114

5791. Collective electron antiferromagnetism. E. W. ELCOCK. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 295–7 (*March*, 1954).

Modifies the earlier treatment due to Lidiard [Abstr. 2567 (1954)] by considering the case where the applied field is not parallel to the antiferromagnetic axis. The mean value of the ratio $\chi(0)/\chi(T_c)$, where T_c is the Curie temperature and $\chi(T)$ the susceptibility at temperature T, is shown to lie between 2/3 and 1 if there is incomplete saturation at 0°K, such values being observed. If there is complete saturation the value of the ratio is 2/3. E. P. WOHLFARTH

538.122

5792. An application of conformal transformation to the investigation of the magnetic field between galvanometer pole-pieces. W. SNOWDON AND N. DAVY. *Brit. J. appl. Phys.*, **5**, 146–51 (*April*, 1954).

An accurate calculation is made of the magnetic potential, the associated stream function, and the

strength of magnetic field along the boundary and axes of symmetry of a figure which represents the cross-section of the two pole-pieces and central core of a galvanometer. In addition the field strength along a locus in the space between the core and pole-pieces is determined precisely. Part of this locus lies along the path of the moving coil of the galvanometer. The method used is an extension of the usual procedure of combining Schwartz–Christoffel transformations. The paper includes a map of the field obtained by an experimental method which employs the calculated values of the stream-potential function round the boundary of the figure. A.

538.21 : 771.534.5

Magneto-optical method of domain observation. *See Abstr.* 5212

538.22 : 548.736.3

5793. Magnetic transitions and structural changes in hexagonal manganese compounds. B. T. M. Willis and H. P. Rooksby. *Proc. Phys. Soc. [London] B*, **67**, 290–6 (*April*, 1954).

The lattice parameters of the isomorphous compounds MnAs, MnSb and MnBi have been measured over a temperature range which includes the temperatures at which certain magnetic transitions occur. Characteristic changes develop near the magnetic transition temperatures and are of two kinds: (*a*) discontinuous changes of lattice dimensions (MnAs at 40°C, MnBi at 320°C), which are associated with magnetic transitions of the first order, (*b*) discontinuous changes of the temperature derivatives of the lattice parameters (MnAs at 130°C, MnSb at 320°C), associated with second-order magnetic transitions. Correlation of the results on MnAs and MnSb with those obtained by Greenwald on MnTe indicates that the magnetic exchange energy for manganese atoms at a distance r apart is a maximum for $r = 2{\cdot}94$ Å. The magnetic change which takes place in MnBi near 440°C is caused by decomposition of the material and is not a Curie point phenomenon. A.

538.221

5794. Electronic origins of the transformations and the analogous phenomena in iron and the nature of its spontaneous magnetism. M. Satô. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4**, 597–606 (*Dec.*, 1952).

From the results of the investigations on zinc and copper and on the regularities existing in the anomalous temperatures of iron, it was inferred that the "structure levels," E_+ and E_-, of the valence electron in this metal might be denoted by $(A_2, B_2)^2 G_{-3,-2,-1,0,1,2,3}$; and $(A_2, B_2)^5 D_{4,3,2,1,0}$, respectively. Of these notations, (A_1, B_1) and (A_2, B_2) respectively represent two pairs of atoms forming diatomic molecules, and suffix numbers, being the values of J, were written in order of the energy positions. Further, assuming that the iron crystal is built up of equal numbers of the above molecules, the electronic origins of the transformations of A_2, A_4, and melting, and phenomena allied to them were explained by attributing them to the transitions between two adjacent components of the above multiplets. The spontaneous magnetism of iron crystal was explained to be due to the term $(3d)^6\ ^5D_4$ of the atoms in the molecule (A_2, B_2). A.

538.

5795. Antiferromagnetism of manganese. Patrick. *Phys. Rev.*, **93**, 370 (*Feb. 1, 1954*).

Measurements of resistance and thermoelectric power of Mn show anomalies near the Neel temperature. A thermocouple of degassed Mn and degassed Mn gives evidence of a Mn transition 100 K.

538.

5796. Neutron diffraction study of the antiferromagnetic transition in α-Fe_2O_3. L. M. Corliss, J. M. Hastings and J. E. Goldman. Letter in *Phys. Rev.*, **93**, (*Feb. 15, 1954*).

Describes experiments on the temperature variation of the height of the (111) neutron diffraction peak for a natural and an artificial crystal. The transition temperature of the natural crystal was found to be about −24°C, of the artificial crystal about +. The transition is fairly sharp and is unaffected by the action of a magnetic field of strength 6000 oersteds. E. P. Wohlfarth

538.221 : 535.3

5797. Temperature dependence of ferromagnetic resonance line width in a nickel iron ferrite: a new mechanism. J. K. Galt, W. A. Yager and F. R. Merritt. Letter in *Phys. Rev.*, **93**, 1119 (*March 1, 1954*).

The ferromagnetic resonance line width of a crystal of $(NiO)_{0.75}(FeO)_{0.25}Fe_2O_3$ at 24 000 Mc/s rises with temperature from 4 to 400°K, but shows an intermediate maximum of 300 oersteds at 160°K. The high temperature loss is related to the conductivity, but the low temperature maximum may be related to the order-disorder relationship of the Fe^{++} and Fe^{+++} ions, which is coupled to the magnetization through magnetostriction and involves a time lag in its establishment. D. W. Wood

538.221 : 539.3

5798. On the effect of heat treatment on the magnetic properties of iron-aluminium alloys. III. On the change of electric resistance and magnetostriction due to water quenching. H. Masumoto and H. Saito. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4**, 338–46 (1952).

The relation between the change of resistance, magnetostriction and the quenching temperature and that between those properties and the concentration have been studied.

538.221 : 53

5799. Ferromagnetic domain patterns on nickel crystals. I. Domain patterns on the magnetically important surfaces of unmagnetized nickel crystals. M. Yamamoto and T. Iwata. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 433–59 (*Oct.*, 1953).

Clear and interpretable ferromagnetic domain patterns have been observed, by the use of a ultra-magnetic colloid technique, on the four magnetically important surfaces, namely on the (110), (211), (100) and (111) surfaces, of unmagnetized nickel single crystals. A number of types of domain pattern are observed according to the orientation of crystal surface with respect to the crystal axes have been analysed domain-theoretically in some detail.

the general nature of the magnetic domain tures in cubic crystals having directions of easy netization along trigonal axes could have been ted. The (110) surface of nickel crystals presents le plane patterns, tree patterns of three kinds sponding to the tree patterns of two kinds on (100) surface of silicon-iron crystals, and parallelo-ined patterns composed of 180° and 71° or 109° s. The domain patterns observed on the (211) ace is unique, while those on the (100) and (111) aces are complicated, as was expected. It was found that the above-mentioned domain struc-s are influenced remarkably by the direction of rating magnetic field applied for demagnetization. patterns and deformed maze patterns have been erved on disturbed crystal surfaces. A.

538.222

0. **Some magnetic properties of diphenyl trinitro-yl hydrazyl at low temperatures.** H. J. GERRITSEN, OGDEN, H. M. GOODMAN AND J. VAN DEN HANDEL, *ibid.* **20**, 13–14 (*Jan.*, 1954).

paramagnetic resonance experiments down to , K give $g = 2{\cdot}00_0$. Susceptibility measurements e a Curie temperature of $-0{\cdot}1°$ and a small lation indicative of the onset of antiferromag-m below 2°K. D. H. WHIFFEN

538.222

1. **Rotating fields in waveguides and the sign of Landé factor of paramagnetic resonances.** A. STLER. *C.R. Acad. Sci.* [*Paris*] **238**, 669–71 *b.* 8, 1954) *In French.*

When $\nu = \sqrt{2}\nu_{critical}$ the magnetic field at 4 from edge of a rectangular waveguide is essentially ularly polarized and the intensity of paramagnetic nance at this point is a maximum or zero accord-to the sign of g. D. H. WHIFFEN

538.222

2. **Paramagnetic resonance in gases at low fields.** A. GARSTENS. *Phys. Rev.*, **93**, 1228–31 (*March* 15, 54).

A classical analysis has been made of the para-gnetic resonance of a gas composed of a collection magnetic dipoles in an external static magnetic ld H_0 for both circularly and linearly polarized fields at right angles to H_0. Assuming that during isions the dipoles have components only along the direction one obtains for the circularly polarized se equations similar to those of Bloch with the gle parameter τ, the mean time between collisions. e expression for paramagnetic absorption thus ained suffers from the defect that at zero external ld it does not reduce the Debye formula, as it ould. If a Boltzmann distribution of the x and y mponents of the magnetization is assumed during isions, the absorption formula is modified and rectly reduces to the Debye formula. For a nearly polarized r.f. field, one obtains as the absorp-on formula the sum of two terms. This again does t reduce to the Debye formula. Introducing a oltzmann distribution of magnetization during isions one obtains a corrected formula in which sorption does not vanish at low fields. A.

538.222

5803. **Proton relaxation in water.** G. CARAVETTA AND L. CARACCIOLO. *Phys. Rev.*, **93**, 1241 (*March* 15, 1954).

A determination of the thermal relaxation time of protons in pure water gives the value $1{\cdot}6 \pm 0{\cdot}2$ sec., in very good agreement with theory. The O_2 molecule in aqueous solution seems to have a μ_{eff} of 1·2 Bohr magnetons for the relaxation processes. A.

538.222

5804. **Magnetic susceptibilities of K_2MoCl_6 and $RuCl_3$.** C. EPSTEIN AND W. KLEMM. *J. chem. Phys.*, **22**, 634–5 (*April*, 1954).

Measurements were made in the temperature range 76°–297°K. Curie's law is obeyed by both salts. The magnetic moments 1·61 and 2·05 are calculated for the ions Mo^{3+} and Ru^{3+}, respectively. A.

538.222

5805. **The magnetic susceptibility of Nd metal.** J. F. ELLIOTT, S. LEGVOLD AND F. H. SPEDDING. *Phys. Rev.*, **94**, 50–1 (*April* 1, 1954).

The magnetic susceptibility of neodymium metal has been measured over the temperature range of 20·4 K–300 K. The metal was found to obey a Curie–Weiss law above 145°K with a paramagnetic Curie point of −16°K and an effective moment of 3·68 Bohr magnetons. Near 145°K there appears to be a change in slope of the curve of $1/\chi$ *vs.* T. From 145 K to 20·5 K the metal again obeys a Curie–Weiss law with a paramagnetic Curie point of about 1°K and an effective moment of 3·35 Bohr magnetons. The low-field susceptibility at 20·4°K is much larger than predicted by the low-temperature Curie–Weiss law, and the susceptibility has a definite field dependence. A.

538.222 : 535.5.061.3

5806. **Tables for use in the interpretation of paramagnetic behavior below 1°K; for the chromic alums ($J = 3/2$).** R. P. HUDSON AND C. K. MCLANE. *J. Res. Nat. Bur. Stand.*, **52**, 33–5 (*Jan.*, 1954).

The method of interpreting susceptibility and entropy data, obtained in adiabatic demagnetization experiments, by means of the theory of Hebb and Purcell (1937) in order to derive absolute temperatures is recounted briefly. This forms an introduction to tables that enable one to carry out this procedure for the case of the chromic alums. A.

538.222 : 548.7

5807. **Paramagnetic resonance in neutron-irradiated diamond and smoky quartz.** J. H. E. GRIFFITHS, J. OWEN AND I. M. WARD. *Nature* [*London*] **173**, 439–40 (*March* 6, 1954).

The paramagnetic absorption spectra were measured for neutron-irradiated diamond from 20°–298°K, and for neutron-irradiated smoky quartz at 90°K using wavelengths of 1·2 and 3·2 cm. Two main types of line were found for diamond, one isotropic ($g = 2{\cdot}0028 \pm 0{\cdot}0001$) and the other anisotropic, mean $g = 2{\cdot}0027 \pm 0{\cdot}0005$, $g_\parallel - g_\perp = 0{\cdot}0036 \pm 0{\cdot}0005$. For quartz the results indicated an axial set of paramagnetic ions with the same principal $g_\parallel = 2{\cdot}00 \pm 0{\cdot}05$, $g_\perp = 2{\cdot}00 \pm 0{\cdot}05$. Subsidiary lines were

also found and explanations of the observed phenomena are put forward which take into account the effect of heating the diamond, and of impurities in quartz. J. THEWLIS

538.24

5808. On the magnetic after-effect due to the irreversible displacement of the domain boundary. V. S. MAEDA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4**, 376–85 (*Aug.*, 1952).

For Pt IV, see Abstr. 7408 (1952). The magnetic after-effect of the alloy Ni_3Mn was investigated by a statical method of measuring the change of magnetization. It was found that the alloy showed a creep with an extraordinary long period in the course of magnetic after-effect compared with ferromagnetic alloys measured previously. The creep of magnetization was well explained by the author's theory of magnetic after-effect. A.

538.24 : 539.67

On the internal friction of ferromagnetic substances. *See Abstr.* 6064

538.247

5809. Ballistic demagnetization factors for samples with rectangular cross-section. J. ŠTERNBERK. *Czech. J. Phys.*, **3**, 85–93 (*March*, 1953) *In Russian.*

The ballistic demagnetizing factors N were determined for rectangular steel bars having cross-sections 1×9, 2×10, 3×10 and 5×10 mm. The demagnetizing factors were measured by the conventional ballistic reversal method for the normal induction curve of the material and pursued as a function of susceptibility κ. The measured values N for the range of increasing and of decreasing κ are listed and compared with the measurements of other authors. It was ascertained that after an initial increase the demagnetizing factor remains constant up to the point κ_{max} after which it decreases approximately linearly. According to the kind of sample, it attains in the range of constancy 60 to 75% of the value valid for the corresponding ellipsoid. The back shearing curve is in all cases of the same shape as with cylindrical bars, i.e. to about $B = 10\,000$ G it is linear and then it curves towards the axis of ordinates. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.52

5810. Induction in a conducting sheet by a small current-carrying loop. J. R. WAIT. *Appl. sci. Res. B*, **3**, *No.* 3, 230–6 (1953).

The problem of a small a.c.-carrying loop situated over a thin plane sheet of conducting material is solved. The cases are considered where the loop axis is oriented both perpendicular and parallel to the plane of the sheet. A.

538.52 : 550.837.6

5811. The fields of a line source of current over a stratified conductor. J. R. WAIT. *Appl. sci. Res. B*, **3**, *No.* 4–5, 279–92 (1953).

The problem of a line source of alternating current situated over a stratified dissipative medium is theoretically investigated. Special cases of the gener solution are studied in detail and several illustrati curves are given. The results have application stratigraphic investigations of the earth's crust.

538.52 : 550.837

5812. Induction by a horizontal oscillating magnet dipole over a conducting homogeneous earth. J. WAIT. *Trans Amer. Geophys. Un.*, **34**, 185–8 (*Apr* 1953).

The magnetic field of an oscillating horizont magnetic dipole on the surface of a homogeneo earth is calculated. For lower frequencies, whe displacement currents can be neglected, the magnet field on the surface of the earth can be represent in terms of transcendental and cylindrical function Particular attention is paid to the vertical componen which vanishes as the conductivity of the ear approaches zero. An explicit formula is given f the value of this component in parametric for involving the conductivity, frequency and distance the observer. The magnetic field componen tangential to the earth's surface are also considere

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.

5813. On the transfer of energy between electr magnetic dipoles. J. L. SYNGE. *Proc. Roy. Irish Aca A*, **56**, *No.* 1, 1–11 (*Jan.*, 1954).

The Hertzian dipole is taken as a source and second Hertzian dipole, with changed sign, as sin The electromagnetic field in the presence of th source dipole and sink dipole is investigated. Th flow of energy out to infinity is found to be th algebraic sum for the two dipoles, regarded as existin each alone in space. G. E. BROW

538.56

5814. The diffraction of electromagnetic waves on a annular disc. V. SACHL. *Czech. J. Phys.*, **3**, 177–8 (*Sept.*, 1953).

Deals with incidence of monochromatic linearl polarized electromagnetic waves on to a perfectl conducting annular disk. For the x-component c the surface current density induced in the disk t which the whole problem is transformed an integra equation is derived valid for all values of the wave length. On the assumption that the width of th annulus is large compared to the wavelength a approximate solution for the surface current density i given based on the method of Schwarzschild. A

538.56

5815. Comments on "Diffraction of electromagneti waves by an aperture in a large screen." J. H CRYSDALE. Letter in *J. appl. Phys.*, **25**, 269–70 (*Feb* 1954).

Discusses the validity of some boundary condition adopted by Bekefi [Abstr. 616 (1954)]. It is show that the formula for the diffracted field obtained b Bekefi can be derived by a simple argument based o the physical aspects of the problem. G. D. SIM

538.566

816. Investigation of a new form of micro-wave interferometer for determining the velocity of electromagnetic waves. K. D. FROOME. *Proc. Roy. Soc. A*, **23**, 195–215 (*April* 22, 1954).

A very sensitive symmetrical microwave interferometer utilizing four electromagnetic horns is described. Operating at 24 005 Mc/s ($\lambda \simeq 1{\cdot}25$ cm), its basic function is to measure wavelength in air, and the resulting value when multiplied by frequency and refractive index gives phase velocity *in vacuo*. Because of diffraction, the velocity thus obtained is higher than the true free-space value by an amount dependent upon the size of the horns and the spacing between them. The investigation has been primarily concerned with the use of the instrument under conditions of large diffraction correction (up to the equivalent of 100 km/s), so that the accuracy obtainable in eliminating this effect could be assessed. The effect of deliberate distortion of the transmitted and received wave-fronts upon the diffraction correction has also been ascertained. In addition, errors arising from random and systematic scattering of the microwave energy between transmitting and receiving horns have been investigated. The ten observations made under optimum conditions have been used to derive a preliminary value for the free-space velocity of electromagnetic waves *in vacuo*, namely, $c_0 = 299\,793{\cdot}0 \pm 0{\cdot}3$ km/s. The error limit given represents the standard deviation of single observations in statistical combination with estimated systematic errors. A.

538.566 : 621.372.8

5817. Guided electromagnetic waves in anisotropic media. A. A. T. M. VAN TRIER. *Appl. sci. Res. B*, **3**, *No.* 4–5, 305–71 (1953).

The propagation of guided waves in anisotropic media has recently become of interest in two fields, viz. in the interpretation of ferromagnetic resonance experiments and in the construction of microwave quadrupoles which violate the reciprocity relation. Both cases require the solution of Maxwell's equations in a volume which is enclosed by perfectly conducting walls and which is completely or partially filled with a medium whose magnetic permeability is described by a second-order tensor. An account is given here of theoretical and experimental work on this subject. Pt I contains a short survey of the theory of guided waves in isotropic media and of the problems arising in anisotropic media, together with a historical synopsis. Pt II gives a general formulation of the theory of guided waves in anisotropic media, comprising the existing theories, and also deals with some new applications. In Pt III a cavity technique for measuring Faraday rotations is described which has several advantages over older techniques. In Pt IV experimental results obtained for the series of Ferroxcubes IVA, B, C, D, E are collected. Pt V finally deals with the physical interpretation of these results. In particular the experimental data are compared with Rado's theory of the permeability tensor in non-saturated ferromagnetics. A.

538.566 : 621.372.8

5818. Radiation properties of the open end of a rectangular waveguide when the end plane is inclined to the guide axis. G. S. SANYAL. *Indian J. Phys.*, **27**, 465–75 (*Sept.*, 1953).

The far-zone field intensity pattern due to radiation from the obliquely cut open end of a rectangular waveguide is studied experimentally and theoretically in the microwave frequency range. The waveguide used had internal dimensions of $0{\cdot}9$ in. $\times 0{\cdot}4$ in. and the exciting wavelength was in the range $3{\cdot}2$–$3{\cdot}5$ cm. The experimentally obtained radiation patterns show that in the H-plane of the waveguide, the beam width of the major lobe decreases with the increase of the angle of inclination of the end plane to the guide axis and a compromise between the beam width and the intensities of the minor lobes is affected when the inclination is 50°. Making certain simplifying assumptions the normalized radiation patterns are calculated by applying the diffraction theory. The possible sources of discrepancy between the calculated and experimental patterns are discussed. To check the matching property of the open end to free space, voltage standing-wave ratio measurements were also carried out for various inclinations of the end plane. It has been found that the v.s.w.r. in the wavelength range tested is not high and the matching properties improve when the inclination is large, e.g. 70°. A.

538.566 : 621.372.8 : 621.317.75

5819. An analyser of elliptic vibrations for circular guide in the 3 cm band. G. RAOULT AND A. MARCON. *C.R. Acad. Sci.* [*Paris*] **238**, 218–20 (*Jan.* 18, 1954) *In French.*

An analyser for the determination of the components of an elliptically polarized H_{11} wave in a circular guide. G. D. SIMS

538.566 : 621.396.677

5820. Radiation from a ground antenna. J. R. WAIT. *Canad. J. Technol.*, **32**, 1–9 (*Jan.*, 1954).

It is shown that a horizontal electric dipole can radiate vertically polarized waves along the surface of a finitely conducting ground. This result is then employed to calculate the fields of a horizontal aerial of finite length. Particular attention is paid to the shape of the ground-wave field pattern for aerials of the travelling-wave type. A.

538.566.2 : 621.317.79 : 621.396.11

5821. An analogue computer for the solution of the radio refractive-index equation. W. E. JOHNSON. *J. Res. Nat. Bur. Stand.*, **51**, 335–42 (*Dec.*, 1953).

The solution to the equation provides information on tropospheric radio propagation in the very high and ultrahigh regions. An analogue computer is developed to solve this equation by utilizing basic computation circuits incorporated into a null-balance bridge circuit. A unique feature of this computer is the modification of a linear 10-turn potentiometer so that its output to input voltage ratio *v.* rotation closely approximates the exponential-type curve of the saturated water-vapour term in the refractive-index equation. A.

538.566.3

5822. Determination of the sense of polarization of the magneto-ionic *z*-component. B. LANDMARK. *Tellus*, **4**, 319–23 (*Nov.*, 1952).

The sense of polarization of the third magneto-ionic component, the *z*-component, was determined in a

number of cases at Tromsö during October, 1951. The observations showed without exception that the z-component was polarized in the same way as the ordinary component. A.

538.566.3

5823. Propagation of plane electromagnetic waves in a homogeneous plasma (ionosphere). R. JANCEL AND T. KAHAN. *J. Phys. Radium*, **15**, 26–33 (*Jan.*, 1954) *In French.*

Mathematical analysis, considering a homogeneous ionosphere in the presence of a constant magnetic field. Considerations are given to the dielectric properties of the layer and the phase and group velocity, polarization and attenuation of the waves. The limitations of the assumptions are carefully stressed. G. M. BROWN

538.566.3 : 621.396.11

5824. High-frequency scatter sounding experiments at the National Bureau of Standards. R. SILBERSTEIN. *Science*, **118**, 759–63 (*Dec.* 25, 1953).

Four different types of presentation of radio back-scatter echoes as used at the N.B.S. are described: intensity/range and range/time records at a fixed frequency, plan position indicator (radar type) and sweep-frequency (P', f) techniques. Interpretations of echo patterns are in all cases difficult, and applications to skip-distance determination somewhat uncertain. G. M. BROWN

MAGNETIC EFFECTS 538.6

538.614 : 538.221

5825. Magnetic domains by the longitudinal Kerr effect. C. A. FOWLER, JR AND E. M. FRYER. *Phys. Rev.*, **94**, 52–6 (*April* 1, 1954).

Rotation of the polarization plane of obliquely incident light reflected from a polished ferromagnetic surface is successfully employed to reveal the anti-parallel domains lying in the surface of a large single crystal of silicon iron. This Kerr magneto-optic effect is the basis of two methods of domain observation which are described in detail: (1) the optical probe method in which a small, focused beam of plane polarized light scans the crystal surface before being reflected into a photomultiplier tube located behind the Nicol prism analyser, and (2) the photographic method in which the crystal surface is broadly illuminated with polarized light and the reflected beam is photographically recorded after passage through the analyser. The truly saturated character of the domains is demonstrated, and the directions of the domains are assigned without ambiguity. Domain wall movement and Barkhausen discontinuities are revealed in photographs taken as the crystal is subjected to a changing magnetizing field. Possible applications and limitations of the method are discussed. A.

538.63 : 538.66 : 536.7

5826. Thermodynamical theory of galvanomagnetic and thermomagnetic phenomena. I. Reciprocal relations in anisotropic metals. R. FIESCHI, S. R. DE GROOT AND P. MAZUR. *Physica*, **20**, 67–76 (*Fe*... 1954).

With the method of De Groot and Mazur (to ... published), which allows treatment of vectori... phenomena, the following reciprocal relations a... derived from microscopic reversibility $L_{ss}(B)$ ... $L^{\dagger}_{ss}(-B)$, $L_{ee}(B)=L^{\dagger}_{ee}(-B)$, $L_{es}(B)=L^{\dagger}_{se}(-B)$, whe... L_{ss} is the heat conduction tensor, L_{ee} the electrical co... duction tensor, L_{es} and L_{se} the tensors describing t... cross-effects, and where the sign † indicates tran... pose matrix. The relation between the cross-effects ... a non-trivial example of a reciprocal relation derive... from the formulation of microsopic reversibility wi... variables, which are even and odd functions ... particle velocities (Casimir's α- and β-variables).

538.63...

5827. On the geometrical arrangement in Hall effe... measurements. V. FRANK. *Appl. sci. Res. B*, **3**, *No.* ... 129–40 (1953).

A discussion of the short circuiting effect of th... current electrodes in Hall effect measurements ... given for an arbitrary geometrical arrangement. ... is shown that (for singly connected geometries) th... correction to be applied is given by a universa... function of only one parameter which is characteristi... of the geometry and which can be determined b... measurement. The theory is experimentally verifie... for a particular geometry by measurements on copper. A...

538.63...

5828. Spontaneous Hall effect in ferromagnetics. J. SMIT AND J. VOLGER. Letter in *Phys. Rev.*, **92**, 1576–7 (*Dec.* 15, 1953).

Experimental results suggest that the spontaneous Hall resistivity of Ni alloys varies with temperature in the same way as the resistivity. It is concluded that neither internal dipole fields, spin-orbit interaction or the inhomogeneous magnetic field induced by the primary current, are responsible for the spontaneous Hall voltage. A. E. DE BARR...

538.632 : 538.114

5829. Hall effect in ferromagnetics. K. KONDO. *Sci. Rep. Saitama Univ. A*, **1**, *No.* 2, 69–87 (1953).

The effect in ferromagnetics, consisting of two parts, the ordinary Hall effect proportional to the magnetic field, and the extraordinary Hall effect, proportional to the intensity of magnetization, is discussed, using the electronic theory of metals. The purpose is to decide whether the periodic distribution of electrons due to the lattice structure of metals is responsible for the extraordinary effect. The gauge transformation treatment of Jones and Zener is applied to derive Boltzmann's equation of distribution function in the presence of magnetic and electric field, disregarding lattice vibration and the correlation effect of electron distribution, which are, of course, responsible for the extraordinary effect. Numerical calculations are crudely performed for nickel, and the calculated field parameter is of the same order of magnitude as that observed at liquid air temperature and as that extrapolated to 0°K, but opposite in sign to the latter. This disagreement in sign with that at 0°K is important from the standpoint of this study, but it may be due to the omission of the above two effects and to the poor approximation of the wavefunction used. A.

538.652

ongitudinal magnetostriction in nickel-cobalt
. YAMAMOTO AND R. MIYASAWA. *Sci. Rep. Tôhoku Univ. A*, **5**, 22–33 (*Feb.*, 1953).

igitudinal magnetostriction in magnetic fields
) oersteds of about fifty, annealed, nickel-
loys have been measured with an optical-
hod and the dependency of the magnetostric-
on the composition, magnetic field and intensity
agnetization has been thoroughly investigated.
ncertainties remaining in previous investigations were
clarified, and some new facts found. A.

538.652

5831. On the magnetostrictive constants of face-centered cubic nickel-cobalt alloys. M. YAMAMOTO AND R. MIYASAWA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 113–23 (*April*, 1953).

Fairly precise information has been obtained on the two principal magnetostrictive constants, λ_{100} and λ_{111}, of face-centred cubic nickel-cobalt alloys, by analysing theoretically the measured data obtained previously by the present authors on the longitudinal magnetostriction of polycrystalline specimens and combining them with the already known data for the magnetostrictive constants of nickel. The information thus obtained indicates that the composition dependence of the magnetostrictive constants may be expressed by the following two equations: $\lambda_{100} = (-49 + 1{\cdot}96C) \times 10^{-6}$ and $\lambda_{111} = (-30 + 0{\cdot}09C \times 10^{-6}$, where C is the composition expressed in weight per cent cobalt. It follows, then, that the saturation magnetostriction of polycrystalline specimens, λ_s, may be given by the expression: $\lambda_s = (-38 + 0{\cdot}84C) \times 10^{-6}$, which is shown to be in a fairly good agreement with the measured data. A.

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11 : 548.7

5832. Imperfections in matter. G. W. RATHENAU. *Philips tech. Rev.*, **15**, 105–113 (*Oct.*, 1953).

Generally, the properties of solids are explained theoretically by a model of the periodic space lattice, but certain properties and many crystal phenomena depend on small departures from periodicity. The occurrence of such lattice imperfections is shown to be correlated with the increase in the probability of a given state (increase in entropy), or, by the evasion of rate-limiting factors, with an acceleration of changes in structure which lead to a condition of lower final energy. The former is illustrated by a consideration of the interaction between physical and chemical lattice imperfections, e.g. the cases of controlled valency substances and interstitial solutions, and the latter by phenomena such as the growth of crystals from solutions, segregation, recrystallization and order-disorder transitions, where the processes are in principle determined by the atomic interaction as manifested in nucleation, diffusion and interfacial tension. Some notes are included on the nature of the lattice imperfections. 27 refs. 11 figs.

H. H. HODGSON

MOLECULAR STRUCTURE 539.13

539.13 : 534.23

Transfer of vibrational energy in hydrocarbons. *See Abstr.* 5375

539.132 : 539.153 : 537.56

5833. The determination of electron affinities. H. O. PRITCHARD. *Chem. Rev.*, **52**, 529–62 (*June*, 1953).

A critical review of experimental and theoretical work (1930–52), with results for electron affinities of atoms, molecules and free radicals. Methods discussed include direct electron-bombardment and mass-spectrometric methods, studies of atom-ion equilibria near thermionic filaments, calculation of ionic lattice energies, electrode-kinetic studies and spectroscopic extrapolation methods. 188 refs.

J. HAWGOOD

539.132

5834. A quantum-mechanical study of the fluorine molecule. H. DINGER AND I. FISCHER-HJALMARS. Letter in *J. chem. Phys.*, **22**, 346 (*Feb.*, 1954).

The binding energy has been determined treating F_2 as a two-electron problem. The effective nuclear charge, determined by a variation method, was <2, showing that care is needed when screening constants are transferred to less accurate treatments where some electrons coincide with the nuclear charge. J. JACOBS

539.132

5835. The dissociation energy of fluorine. R. T. SANDERSON. Letter in *J. chem. Phys.*, **22**, 345 (*Feb.*, 1954).

It is argued that because of the very intense reactivity of fluorine no measurements on it at high temp. in nickel and, probably, all other materials of apparatus construction can be unambiguously interpreted. Graphical plots of the dissociation energies of the halogens against the principle quantum number of the valence electrons, polarizabilities, melting points, crit. temps., electronegativities, ionization potentials, reciprocals of internuclear distance, dissociation energies of the hydrogen halides indicate a value of about 95 kcal for F_2 in contrast to the (accepted) value of 35 kcal obtained by a variety of experimental methods. W. GOOD

539.132

5836. Force constants of hydrides. S. S. MITRA. Letter in *J. chem. Phys.*, **22**, 564 (*March*, 1954).

It was found that the force constants of hydrides of elements of the same period showed a linear dependence on the number of outer electrons. This is shown for elements of the second and third periods. The force constant for SH, which has not been observed, is predicted from this relation to be $4{\cdot}154 \times 10^5$ d cm^{-1}. The force constants of hydrides

of second-period elements are directly proportional to those of the corresponding elements in the third period. From this the SH force constant is predicted as $4 \cdot 184 \times 10^5$ d cm^{-1}. A. J. TAYLOR

539.132

5837. Hybridization and ionic character in the hydrogen chloride molecule. P. N. SCHATZ. *J. chem. Phys.*, **22**, 695–8 (*April*, 1954).

Hybridization in the HCl molecule has been studied in terms of an *spd* hybrid valence bond function including an ionic term ($H^+ - Cl^-$). The results indicate that the quadrupole coupling constant for gaseous HCl (not known experimentally) may be of the order of 100% larger than the value reported for the solid. It is found that the quadrupole coupling constant depends principally on the amount of ionic character and does not distinguish among various possible hybridizations. The sign of the dipole moment is discussed briefly. A.

539.132 : 535.343

5838. Dissociation energies and spectra of diatomic molecules. A. G. GAYDON. *London: Chapman and Hall* (1953) xiii + 262 *pp.*

Review in *Nature* [*London*] **173**, 514 (*March* 20, 1954).

539.132 : 535.375.5

Raman spectra and potential constants for CF_3Cl, CF_3Br, and CF_3I. *See Abstr.* 5485

539.132

5839. On the rotation of irregular groups in molecules. B. A. ARBOUZOV. *J. Chim. phys.*, **50**, 647–51 (*Nov.–Dec.*, 1953) *In French.*

There exists a discrepancy between measured parachor values and values obtained from dipole moments, either measured or calculated with the hypothesis of free rotation. This might be explained by the assumption that the rotation is somewhat restricted, because of overlapping spheres of influence of the van der Waals forces. Some examples including trimethyl borate, amino phosphites and esters of phosphoric acid are discussed. A. J. TAYLOR

539.132

5840. Influence of anharmonicity on the calculation of the potential function of the molecules C_2H_4 and H_2O. C. MANNEBACK AND A. RAHMAN. *Ann. Soc. Sci. Bruxelles, Sér.* I, **67**, *No.* 3, 275–84 (1954) *In French.*

In the absence of sufficient experimental information regarding the anharmonicity of molecular vibrations, the difficulties arising in the calculation of the potential function have been studied by taking as examples the case of ethylene and water vapour. It is shown in the case of ethylene that different but equally valid empirical methods of making the anharmonic correction lead to widely different potential functions, the non-diagonal constants of the potential energy matrix being the most affected. The case of water vapour is still more convincing because of accurate knowledge of the anharmonicity of its vibrations. It is also pointed out that the possibility of being able to calculate by means of a certain potential function a set of frequencies agreeing closely with all the observed frequencies is not sufficient for the unqualified acceptance of the potential function, because a equally satisfactory fit can be obtained on using widely different potential function.

539.13

5841. Assignment of torsional frequencies in som halogenated ethanes. N. W. LUFT. Letter in *J. chem Phys.*, **22**, 155–6 (*Jan.*, 1954).

Thermodynamic functions are calculated fc $F_3C–CHCl_2$, $F_3C–CF_2Cl$ and $F_3C–CCl_3$ using to sional frequencies derived from observed Rama shifts. G. I. W. LLEWELY

539.13

5842. Eckart conditions in Wilson's treatment o molecular vibrations. R. J. MALHIOT AND S. M FERIGLE. *J. chem. Phys.*, **22**, 717–19 (*April*, 1954).

The consistency of Wilson's treatment of molecula vibrations with the Eckart conditions is discussed in detail. The necessary conditions for this consistency are written in vector form and the applicability of the equations, thus derived, to the calculation of s vectors is indicated. A

539.132

5843. Calculation of the excited levels of indene. S. RAMAMURTY. *Indian J. Phys.*, **27**, 504–10 (*Oct.*, 1953).

The energy of the excited levels of indene is calculated by the method of anti-symmetrized molecular orbitals. The observed band system at 2952 Å is assigned to a $^1A_1 - {}^3A_1$ transition. The results of the MO and AO methods of treatment are compared. A.

539.132 : 541.4

5844. On the relation between the chemical reactivity and energy levels of the chemical reagent. S. NAGAKURA AND J. TANAKA. Letter in *J. chem. Phys.*, **22**, 563 (*March*, 1954).

In cationoid substitution reactions of aromatic compounds, as the lowest vacant orbital V_S of substituents like Cl^+, NO_2^+, is lower than the highest occupied benzene orbital H_B, large electron transfer to the substituent might occur during the reaction, which would then proceed as between an aromatic cation and neutral radical. For Ag^+, I_2, etc., $V_S > H_B$, and molecular complexes are formed, no reaction occurring. J. HAWGOOD

539.132

5845. Free radicals by mass spectrometry. V. The ionization potentials of methyl, allyl, and benzyl radicals. F. P. LOSSING, K. U. INGOLD AND I. H. S. HENDERSON. *J. chem. Phys.*, **22**, 621–5 (*April*, 1954).

For Pt IV, see Abstr. 8008 (1953). The ionization potentials of these radicals were measured directly by electron impact. The values found were methyl $9 \cdot 95 \pm 0 \cdot 03$ eV, allyl $8 \cdot 16 \pm 0 \cdot 03$ eV, and benzyl $7 \cdot 73 \pm 0 \cdot 08$ eV. The radicals were produced by thermal decomposition of suitable compounds in a mass spectrometer designed for the study of free radicals. Reactions of the radicals after formation led to the expected dimers, but the disproportionation reactions were found to be negligibly slow. A.

539.132

6. On the quadrupole resonance in the solid state odine and bromoform. H. BENOIT AND M. BUYLE-DIN. *C.R. Acad. Sci.* [*Paris*] **238,** 671–3 (*Feb.* 8, 4) *In French.*

or I_2 the resonance near 332 Mc/s has

$$(1/\nu)(d\nu/dT) = -(4{\cdot}0 \pm 0{\cdot}4)10^{-5}$$

l the Zeeman effect shows the I–I bonds to lie in cleavage plane of the crystal. From the $CHBr_3$ onances $Q_{Br^{79}}/Q_{Br^{81}} = 1{\cdot}1955 \pm 0{\cdot}002$. With id cooling a metastable form is obtained with no arent resonance above 77°K, though with slow ling it appears above this temperature.

D. H. WHIFFEN

539.132

47. Anisotropic relaxation of quadrupole spin noes. E. L. HAHN AND B. HERZOG. Letter in *Phys. v.*, **93,** 639 (*Feb.* 1, 1954).

Spin-spin relaxation times of the Cl quadrupole in $KClO_3$ crystals is shown to be a function of the size d direction of a Zeeman magnetic field, though the rmal relaxation times are unaffected. Agreement the details with theory is satisfactory.

D. H. WHIFFEN

539.132

48. Pure quadrupole spectra of solid bromine and dine compounds. K. SHIMOMURA, T. KUSHIDA, N. OUE AND Y. IMAEDA. Letter in *J. chem. Phys.*, **22,** 0 (*Feb.*, 1954).

539.132

49. The pure quadrupole spectrum of solid hexa-lorobenzene and its interpretation. J. DUCHESNE ND A. MONFILS. Letter in *J. chem. Phys.*, **22,** 562 *March*, 1954).

The variations with temperature of the resonant equencies near 38·0 Mc/s were measured. The terpretation of the exact values for several chlori-ated benzenes is in terms of an electronegative effect r Cl substituents and a special ortho effect in which jacent Cl atoms are distorted out of the plane of e ring.

D. H. WHIFFEN

539.132

50. Cl in SO_2Cl [derivatives] pure quadrupole ectra. P. J. BRAY AND D. ESTEVA. Letter in *J. hem. Phys.*, **22,** 570–1 (*March*, 1954).

539.132

51. Nuclear quadrupole resonances in some hlorine compounds. Q. WILLIAMS AND T. L. EATHERLY. Letter in *J. chem. Phys.*, **22,** 572 (*March*, 954).

Observations and interpretation for 1–C12:4–dini-obenzene, 4–Cl3:5–xylenol and ethyl trichlor-liane.

D. H. WHIFFEN

539.132

52. Mathematical analysis of the Hahn spin-echo xperiment. T. P. DAS AND A. K. SAHA. *Phys. Rev.*, **3,** 749–56 (*Feb.* 15, 1954).

It was felt that the averaging procedures employed y Hahn [Abstr. 2922 (1951)] in his theory of the spin-echoes" requires modification in several espects. A more satisfactory averaging procedure has been introduced here, and gives substantially the same results as those obtained by Hahn. A.

539.132

5853. Some modifications of the free-electron model. T. NAKAJIMA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5,** 98–111 (*Feb.*, 1953).

The perimeter-free-electron model which is rather a crude approximation for the calculation of the π-electronic spectra of a conjugated system is modified at some points. How the linear addition of a conjugated chain or phenyl groups to benzene will cause red shifts of their spectra with increase of the length of chain or the number of phenyls is discussed. The effects of nuclear substitution with a heteroatom in the benzene ring are studied in the case of pyridine. The red shifts of centre of gravity of the actual singlets of pyridine, compared with that of benzene, are explained by the insertion of a suitable potential well along the perimeter-loop. As a typical non-alternant hydrocarbon, azulene is chosen and its absorption spectrum, electron density and red or blue shifts of the longest wavelength transition on alkylation are calculated. These modifications raise the degree of approximation of the free-electron model to that of simple LCAO molecular orbital treatment. A.

539.132

5854. A note on the hydrogen bond. K. NUKASAWA, J. TANAKA AND S. NAGAKURA. Note in *J. Phys. Soc. Japan*, **8,** 792–3 (*Nov.–Dec.*, 1953).

A method based on perturbation and molecular orbital theory is applied to calculate approximately the contribution of resonance to the stability of the hydrogen bond. A formula is given for the attractive energy due to delocalization of the orbital σ_y in the system $Y \ldots H—X$; this is estimated to be of the order of several kcal/mole. Experimental facts formerly attributed to the inductive effect can also be explained by this delocalization which, moreover, can account for the shift in infrared absorption bands in the system $H—Y \ldots H—X$ by means of changes in the bond-orders. A. J. TAYLOR

539.132

5855. Nonequivalent zinc bonds in chalcophanite. D. P. CRAIG AND A. D. WADSLEY. Letter in *J. chem. Phys.*, **22,** 346–7 (*Feb.*, 1954).

In $ZnMn_3O_7 . 3H_2O$ the three equal Zn–O bonds (length 1·95 Å, interbond angle 90°) are not equivalent to the three Zn–H_2O bonds (2·15 Å, 83°). This can be explained by the fact that, in general, *d* orbitals hybridize more readily towards the more electronegative atoms; in the sp^3d^2 hybrids from Zn, this may cause greater *d* character in the Zn–H_2O bonds at the expense of the Zn–O bonds. J. HAWGOOD

539.132

5856. Self-consistent orbitals for radicals. J. A. POPLE AND R. K. NESBET. Letter in *J. chem. Phys.*, **22,** 571–2 (*March*, 1954).

A direct generalization, to single-determinant states with electrons outside closed shells, of Roothaan's iterative method for LCAO molecular orbitals for closed-shell ground states [Abstr. 2887 (1952)].

J. HAWGOOD

539.132

5857. Use of electron repulsion integral approximations in molecular quantum mechanics. R. S. BARKER, H. EYRING, C. J. THORNE AND D. A. BAKER. *J. chem. Phys.*, **22**, 699–702 (*April*, 1954).

Straightforward theoretical calculation for molecular systems using eigenfunctions built up from atomic orbitals and employing actual and approximate methods for the evaluation of certain integrals have recently been widely applied with considerable success. Most of these calculations have evaluated the difficult multicentred electron repulsion integrals by use of an approximate formula suggested by Mulliken, in terms of Coulombic and overlap integrals. Previous work has indicated the general utility of this relationship. Here, direct numerical comparison is made of actual and approximate values of the multicentre 1*s* orbital integrals. The comparisons indicate that this approximation of integrals is moderately accurate over a wide range of internuclear configurations. Direct calculations of the energy of the linear triatomic hydrogen complex molecule with this approximate integral formula disclose that the total binding energy obtained by the two procedures is different by several kcal/mole. However the energy variation with internuclear separations obtained from the approximate calculations has its minimum very near that obtained using actual integrals. This indicates that energy minimization by variation of the parameters included in the trial eigenfunction may be accomplished using these approximate integrals. Single calculations may then be made using these "best" parametric values. A.

539.133

5858. Investigation of the molecular structure of methyl alcohol by the scattering of thermal neutrons. J. A. JANIK. *Acta phys. Polon.*, **12**, *No.* 1, 45–50 (1953).

Measurements of the cross-section for scattering of slow neutrons show that the theory of Sachs and Teller (valid for molecular gases) is also true for many liquids. This may be verified on the examples of H_2, H_2O, H_2SO_4 and CH_3I molecules. The measurements of the cross-section for CH_3OH molecules give the value $(180 \pm 7) \times 10^{-24}$ cm^2 which is much lower than 231×10^{-24} cm^2 obtained from the theory of Sachs and Teller. This discrepancy is interpreted as due to the influence of torsional oscillations between OH and CH_3 groups in the CH_3OH molecule, in agreement with the microwave experiments of Burkhard and Dennison. A.

539.133

5859. Structure of the perrhenate ion. H. H. CLAASSEN AND A. J. ZIELEN. *J. chem. Phys.*, **22**, 707–9 (*April*, 1954).

Raman and infrared spectra have been obtained for aqueous solutions of perrhenic acid and sodium perrhenate. The spectra are interpreted satisfactorily with the assumption that the perrhenate ion in dilute solutions is ReO_4^- and has tetrahedral symmetry. A.

539.133 : 533.7

5860. Measurement of the effective gas-kinetic cross-section of molecules. E. WEISSMANN. Note in *Naturwissenschaften*, **41**, *No.* 2, 35 (1954) *In German.*

Description of a manometer in which the action of the radiometric pressure is balanced against a torsi couple. When the free path is small compared apparatus dimensions, the maximum deflection of instrument is inversely proportional to the effec cross-section. E. H. SONDHEI

539.133 : 53

5861. Residual entropy of the polar structure of W. N. LIPSCOMB. Letter in *J. chem. Phys.*, **22**, (*Feb.*, 1954).

The configurational part of the entropy of polar is wrongly calculated by Rundle [Abstr. 7014 (19 to be 0·11 e.u. The value calculated according t analogy to the placement of double bonds in infinite layer of graphite is 0·26 e.u. Rund "rocking" disorder makes the entropy too large both polar and nonpolar ice, therefore it seems unnecessary assumption. C. TURI

539.133 : 536

5862. Polar *versus* nonpolar ice. R. E. RUNDL Letter in *J. chem. Phys.*, **22**, 344 (*Feb.*, 1954).

In a previous paper [Abstr. 7014 (1953)] the c figurational part of the entropy for polar ice v calculated wrongly. The corrected value is 0·95 e (observed 0·82 e.u.). If the crystallographic evide for the polar structure is accepted a new source the residual entropy must be found. Vari suggestions are made, but no conclusion is drawn C. TURN

539.133 : 541.12

5863. Nonequivalence of chlorine atoms in ph phorus pentachloride. J. DOWNS AND R. E. JOHNSC Letter in *J. chem. Phys.*, **22**, 143–4 (*Jan.*, 1954).

In an attempt to find evidence for the no equivalence of the apical and equatorial Cl atoms PCl_5, first-order exchange rates for the syste $PCl_5 - Cl_2$, using Cl^{36} as tracer atoms, have be observed. CCl_4 solutions of the reactants we mixed at room temperature. Results indicate homogeneous reaction, together with a rapid init reaction, for which a transition state is suggested a which seems to involve three Cl atoms. Assumi these to be equatorial, it follows that the slow reaction involves the apical atoms, and that there an intramolecular exchange between apical a equatorial positions. Other experiments indica that molecular Cl_2 adds to PCl_3 predominantly in t equatorial positions. A. J. TAYL

539.133 : 541.1

The ortho-para conversion of hydrogen a deuterium on inhomogeneous paramagnetic surface *See Abstr.* 6075

539.1

5864. On the ionicity of gaseous thallous chlorid A. P. ALTSHULLER. Letter in *J. chem. Phys.*, 2 573–4 (*March*, 1954).

An extension of the discussion in Abstr. 2659 (1954

539.133 : 535.343.4–1

Intensities of the infrared bands of carbon suboxid *See Abstr.* 5466

539.133 : 535.375.5

Orientation of water molecules in oxalic ac dihydrate. *See Abstr.* 5486

539.133 : 548.736.3

Molecular structure of B_5H_{11}. *See Abstr.* 6141

539.133 : 535.343.4–14

Microwave spectrum and molecular structure of robenzene. *See Abstr.* 5462

539.133 : 532.77

5865. On abnormally small lengths of chain molecules solution. H. G. FENDLER, W. HUSMANN AND A. STUART. Note in *Naturwissenschaften*, **41**, 3, 61–2 (1954) *In German.*

When long chain molecules like polystyrene were solved in a mixture of a good solvent and a precipitating liquid, it was observed that just below the immiscibility temperature the average size of the molecules became small enough to be consistent with complete flexibility and free rotation of the chain. If this is not feasible, it must be due to strong intramolecular forces, as is also emphasized by the large negative value of the second virial coefficient.

A. J. TAYLOR

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

5866. On the distribution of stable nuclei. S. GUPTA. *Indian J. theor. Phys.*, **1**, 47–66 (*Sept.*, 1953).

Assumptions are made regarding the nature and magnitude of the variation of binding energy of the last proton and neutron in a nucleus. It is shown that these assumptions are consistent with the saturation character of the nuclear forces. These assumptions are applied to study the various systematics in the distribution of stable nuclei. It is found that all the regularities are satisfactorily explained with these assumptions. A.

539.152.1

5867. The reduced widths of nuclear energy levels. A. M. LANE. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. T/R* 1289, 41 *pp.* (1954).

Using the nuclear shell-model, theoretical formulae are derived for the reduced-widths of energy levels in L–S and in j–j coupling. These formulae are used to make predictions about the reduced-widths for nucleon emission of levels in the $1p$ shell, and the results are compared with those obtained experimentally. A.

539.152.1

5868. The energy levels of Ne^{21}. G. VON GIERKE. *Z. Naturforsch.*, **9a**, 164–6 (*Feb.*, 1954) *In German.*

The method previously described [Abstr. 2746 (1954)] was used to determine the energy levels of Ne^{21} in the excitation energy range 8–13·5 MeV. The results are presented in tabular form and compared with those of other workers. J. HUGHES

539.152.1

5869. Effect of $^3P_2 - {}^3F_2$ coupling on nucleon-nucleon scattering. R. M. THALER, J. BENGSTON AND G. BREIT. Letter in *Phys. Rev.*, **93**, 644 (*Feb.* 1, 1954).

A coupling between states of the same j, but different l, is not excluded by the present experimental data. P. T. MATTHEWS

539.152.1

5870. On momentum distribution in nuclei. N. H. MARCH. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 288–90 (*March*, 1954).

The momentum distribution of particles in the nucleus, for an assumed density, is calculated on the Thomas–Fermi model for an oscillator potential, and compared with the exact result. Agreement is reasonably good. P. T. MATTHEWS

539.152.1

5871. The ground states of odd-odd nuclei. C. SCHWARTZ. *Phys. Rev.*, **94**, 95–9 (*April* 1, 1954).

Applications of techniques already developed for the study of atomic spectra to calculations on odd-odd nuclei give some particularly simple results. The spins of the ground states of nearly all odd-odd nuclei measured can be accounted for, and the validity of Nordheim's empirical rules is discussed. A.

539.152.2

5872. Note on a j–j coupling shell model. M. UMEZAWA. *Progr. theor. Phys.*, **10**, 505–8 (*Nov.*, 1953).

Magnetic moments of two odd-odd nuclei, first excited states of light nuclei and nuclear quadrupole moments are treated from the standpoint of the charge symmetric j–j coupling shell model. It is shown that the theoretical magnetic moments calculated according to the assumption given in a previous paper [Abstr. 677 (1954)] are consistent with the experimental magnetic moments. However, it seems that the quadrupole moments of middle and heavy nuclei might not be explainable by j–j coupling of nucleons in nuclei. A.

539.152.2

5873. The nuclear spin quantum number of Si^{29} isotope. R. A. OGG, JR, AND J. D. RAY. Letter in *J. chem. Phys.*, **22**, 147 (*Jan.*, 1954).

Proton magnetic resonance measurements on SiH_4 showed two symmetrical hyperfine satellites of amplitude corresponding to the known abundance of Si^{29} compared to Si^{28} and Si^{30} (spin zero). This confirms the assignment of spin $\frac{1}{2}$ to Si^{29}.

W. J. SWIATECKI

539.152.2

5874. Nuclear spin of $^{239}_{94}Pu$. M. VAN DEN BERG, P. F. A. KLINKENBERG AND P. REGNAUT. Letter in *Physica*, **20**, 37–8 (*Jan.*, 1954).

The spectrum was examined in the region 6500–4000 Å. From the observed hyperfine structure the ground state has spin $\frac{1}{2}$. P. T. MATTHEWS

539.152.2

5875. The nuclear magnetic moments of Xe^{129} and Xe^{131}. E. BRUN, J. OESER, H. H. STAUB AND C. G. TELSCHOW. Letter in *Phys. Rev.*, **93**, 904 (*Feb.* 15, 1954).

Using Xe gas at 50 atmospheres without catalyst, nuclear induction signals lead to $\mu_{129} = -0{\cdot}77255$ and $\mu_{131} = +0{\cdot}68680 \pm 0{\cdot}00002$ n.m. assuming $\mu_P = 2{\cdot}79268$ n.m.: the values are without diamagnetic corrections. Relaxation is through van der Waals forces and is more rapid for Xe^{131} with spin 3/2

and a quadrupole moment than for Xe^{129} with spin 1/2. D. H. WHIFFEN

539.152.2

5876. Magnetic moment of the first excited state of Pb^{204}. H. FRAUENFELDER, J. S. LAWSON, JR, AND W. JENTSCHKE. Letter in *Phys. Rev.*, **93**, 1126 (*March 1*, 1954).

The g-value is measured by observing as a function of applied external magnetic field the directional correlation of the two γ-rays emitted by Pb^{204*} going to the ground state through the first excited state. The preliminary value quoted is $g = -0{\cdot}07$ with possible error $+0{\cdot}06$ or $-0{\cdot}03$. G. E. BROWN

539.152.2

5877. Self-quenched super-regenerative detector for nuclear magnetic resonance. G. SURYAN. *J. Indian Inst. Sci. A*, **35**, 25–30 (*Jan.*, 1953).

This super-regenerator has been used to obtain nuclear magnetic resonance signals and has been found to be simple and sensitive. Experiments with the use of a r.f. coil capable of being rotated with respect to the magnetic field have indicated that the apparatus could be made to respond to induction or absorption. The sensitivity of the apparatus has been determined and is about ten times less than the ultimate possible with the bridge method. A.

539.153

5878. Radiative corrections in positronium. T. FULTON AND P. C. MARTIN. Letter in *Phys. Rev.*, **93**, 903 (*Feb.* 15, 1954).

Results of calculations of all corrections of order $\alpha^5 mc^2$ to the $n = 2$ energy levels of positronium are reported. G. E. BROWN

539.153

5879. Electron affinity of fluorine. J. L. MARGRAVE. *J. chem. Phys.*, **22**, 636–8 (*April*, 1954).

Various theoretical and semi-empirical methods for determining electron affinities of atoms have been applied to fluorine. All results indicate a low value of the electron affinity consistent with recent experimental data, and with the value implied by the recently determined dissociation energy of the fluorine molecule. An extrapolation of the type suggested by Hellmann and Mamotenko appears to give the most reliable value and indicates $E_F = 83{\cdot}2 \pm 0{\cdot}3$ kcal/mole. A.

539.153 : 535.33

5880. The energy levels of Px. A. M. NAQVI. *Proc. Nat. Inst. Sci. India*, **19**, 461–3 (*May–June*, 1953).

H. A. Robinson's values [Abstr. 7202 (1949)] for the energies of the three ^3P levels of the ground configuration of Px appear to be in error. They have therefore been calculated by two different methods of extrapolation along the isoelectronic sequence, which give results in good agreement with one another. A.

539.153 : 535.43

5881. Opacity of a highly compressed hydrogen gas. H. T. H. TSAO. *Astrophys. J.*, **119**, 70–80 (*Jan.*, 1954).

The opacity of a highly compressed hydrogen gas is calculated by considering both the free-free and the bound-free transitions. The electrons are assumed to move in an average potential field of spherical symmetry. For a very dense case such that all hydrogen atoms lose their electrons by pressure ionization, the problem is solved by assuming that medium consists of ions embedded in a highly generate Fermi–Dirac electron gas. The wave fu tions are determined by a simplified self-consist field calculation. For density such that only bound level exists, the broadening of the level due the presence of the neighbouring atoms is obtai by a method similar to that used in the theory solids. The wave functions obtained from the s consistent field calculation are then used for de mining the opacity.

539.15

5882. The chemistry of the isotopes of oxyg M. DOLE. *Chem. Rev.*, **51**, 263–300 (*Oct.*, 1952).

A specialist review covering methods of measur the abundance, methods of separation, chemi application, variation in natural abundance, ator weight of oxygen. Bibliography (121 refs).

539.15

5883. Change of isotopic abundance ratio within sphere due to diffusion. J. T. BRACKEN AND F. SENFTLE. Letter in *J. appl. Phys.*, **25**, 267 (*Fe* 1954).

Exact solution for a sphere initially containing homogeneous mixture of two isotopes in a solve which is embedded in pure solvent. The diffusi constants inside and outside the sphere are assum to be the same, but different for the two isotop This problem is of geological interest. H. LOND

539.155.2 : 542.

5884. Fractionation of isotopes by distillation of so organic substances. D. C. BRADLEY. *Nature* [*Londo* **173**, 260–1 (*Feb.* 6, 1954).

For CCl_4 the substitution of C^{13} for C^{12} increases t vapour pressure whereas the substitution of Cl^{37} f Cl^{35} decreases it [see Abstr. 7854 (1953)]. This resu and similar observations on other compounds can understood by noting that two parts of the vapo pressure equation are mass-sensitive: the vapo pressure "constant" and the latent heat term. The act in opposite directions. The change in latent he is due to the change in zero-point energy of quas oscillations in the condensed phase. Its magnitud depends on the binding of the atom concerned so tha the effect of the latent heat term may or may not b dominant. R. O. DAVI

539.155.2 : 551.510.4

The abundance of O^{18} in atmospheric water an water vapour. *See Abstr.* 6158

539.155.2 : 551.57

5885. The natural distribution of tritium. S. KAUFMAN AND W. F. LIBBY. *Phys. Rev.*, **93**, 1337–4 (*March* 15, 1954).

The abundance of cosmic-ray produced tritium ha been measured in a variety of natural waters in th Mississippi Valley, the Chicago area, and in a fe places elsewhere in the northern hemisphere. Con tents ranging between 0·5 and 67 tritium atoms pe 10^{18} hydrogen atoms have been found. These corre spond to an average cosmic-ray production rate o about 0·12 tritium atoms per cm^2 per second if th total rate of transfer of tritium into the oceans b

eanic rain and snow and by rivers carrying conti-ntal water is taken as being equal to the total pro-ction rate. This is equivalent to assuming short land orage time in terms of eighteen years—the tritium erage life. This production rate corresponds to an in-ntory of about 1900 g, with only about 1% of this in e atmosphere. The tritium contents of vintage wines pear to agree with the time elapsed since bottling, dicating the tritium abundances over the last ghteen years to have been essentially equal to the esent ones. Some of the possible applications of tural tritium to problems of hydrology and meteoro-gy are discussed. The present production rate for itium corresponds to an He^3 escape rate from the rth of about 5×10^7 years or less. A.

539.156

386. Atomic interaction at distances smaller than $\times10^{-9}$ centimetres. O. B. FIRSOV. *Dokl. Akad. auk SSSR*, **91,** *No.* 3, 515–18 (1953) *In Russian.* nglish translation, *U.S. National Sci. Found. NSF-tr-4.*

For small relative velocities ($< 10^8$ cm/sec) the lectronic state changes adiabatically and the nuclei ove in a potential field. Approximate expressions or the potential energy are found for (*a*) the nuclear eparation $R\to0$ $[R < (Z_1+Z_2)^{1/3}\hbar^2/mc^2]$ using he Thomas–Fermi model (T.F.M.), (*b*) larger separa-ions. In the latter case a 1st-order perturbation is pplied to the T.F.M. with suitably placed charges. hus for Ne and A atoms colliding with energy $\times10^3$ eV the distance of nearest approach is given s $0{\cdot}8\times10^{-9}$ cm by (*a*), 2×10^{-9} cm by (*b*), and $\cdot2\times10^{-9}$ cm for pure Coulomb interaction.

F. ANSBACHER

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16

5887. Generalized off-axis distributions from disk sources of radiation. J. H. SMITH AND M. L. STORM. *J. appl. Phys.*, **25,** 519–27 (*April*, 1954).

In the field of shielding it is frequently necessary to calculate biological radiation doses at any point in space due to disk sources of radiation. Such a source is the leakage radiation from an end of a cylindrical reactor. If $G(R)$ is the dose at distance R from a unit point source (e.g. $G\sim e^{-\sigma R}/R^2$) then the dose due to a disk source of radius "a" with source strength $S(\rho)$ is given by

$$D(z,a,\varepsilon) = \int_0^a\int_0^{2\pi} G[(z^2+\rho^2+\varepsilon^2-2\varepsilon\rho\cos\theta)^{\frac{1}{2}}]S(\rho)\rho d\rho d\theta,$$

where (z,ρ,θ) are the usual cylindrical coordinates, $z=0$ is the source plane, and $(z,\varepsilon,0)$ locates the dose point. This integral is quite general, arising in many physical problems. In counter measurements, use of $G=z/(4\pi R^3)$, $S=1$ yields the solid angle subtended by the counter. In neutron physics the slowing down density of neutrons from a circular source of finite radius can be calculated in the age approximation with $G\sim\exp(-R^2/\tau)$. Since for most G's the integral cannot be evaluated in closed form, there are derived three alternative series for $D(z,a,\varepsilon)$ each of which has a direct physical interpretation and a different region of convergence. The results are obtained for a class of analytic functions $G(R)$, the possible singularities of which occur only at $R=0$ for finite R; and for $S(\rho)$ of the form $\Sigma_p S_p\rho^{2p}$. The approach in each case is to expand either the double integral or one of the two repeated integrals in a power series in $\cos\theta$, ε, or ρ prior to performing the detailed integrations. Numerical results are given for the case of a typical shielding function. A.

539.16 : 614.898

5888. A collapsible dry box of flexible P.V.C. supported in a steel frame. R. A. G. WELSHER. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. E/M* 78, 3 *pp.* (1953).

A method of constructing a dry box for the manipulation of radioactive materials from flexible P.V.C., complete with suction unit, supported by a tubular steel frame, is described, together with a collapsing technique for storage or disposal. Possible lines of development are indicated. A.

539.16 : 614.898

5889. Remote handling equipment. A. APPERLY. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. E/R* 1291, 44 *pp.* (1953).

Some remote handling devices designed over the last few years have been standardized for use at A.E.R.E., Harwell. These items are only a selected few and of the remainder this report shows briefly what are available. A.

539.16.08

5890. A new emanation-meter for precision measurements, with wide applications. E. POHL. Note in *Naturwissenschaften*, **41,** *No.* 2, 36–7 (1954) *In German.*

Describes a double chamber system for measuring radioactive contents of gases, etc., with a sensitivity range of about 10^{-7} to 10^{-13} curie. J. D. CRAGGS

539.16.08

5891. Scintillation counting of natural radiocarbon. I. The counting method. J. R. ARNOLD. *Science*, **119,** 155–7 (*Jan.* 29, 1954).

C^{14} samples may be assayed by including them in the liquid organic phosphor of a scintillation counter. Good stability and low background with a 25% counting efficiency are obtained by pulse height analysis and cooling (−20°C) the photomultipliers. A table comparing this method with others shows that contemporary samples in 100 cm^3 of phosphor may be assayed to 0·46% in 48 hr counting time.

M. A. GRACE

539.16.08 : 539.165

5892. A method of preparation of very thin RaE sources. M. DANYSZ AND J. PNIEWSKI. *Acta phys. Polon.*, **11,** *No.* 3–4, 226–9 (1951–52).

A volatilization method of preparation of comparatively strong but extremely thin RaE sources for β-spectroscopy is described. A source 50 μC per 1 mm^2, supported by a conductive film, the whole less than 4 $\mu g/cm^2$ thick was prepared. The others believe that the method described is new in many details. A.

539.16.08 : 545.827

Radium determination by alpha counting. *See Abstr.* 6107

539.163

5893. The branching ratio of K^{40}. G. J. WASSERBURG AND R. J. HAYDEN. Letter in *Phys. Rev.*, **93**, 645 (*Feb.* 1, 1954).

The A^{40}/K^{40} ratio of a potassium feldspar $\sim 8\times10^8$ yr old was determined as $0{\cdot}0537 \pm 0{\cdot}0014$ by an isotope dilution technique; this is essentially in agreement with a branching ratio $[K/\beta^+]$ of 0·13. [Cf. $0{\cdot}06 \pm 0{\cdot}006$ obtained by Russell *et al.*, Abstr. 710 (1954), and by Mousuf, Abstr. 410 (1953)].

A. O. STANESBY

539.163

5894. A search for ^{205}Pb. P. F. D. SHAW AND J. R. PRESCOTT. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 283–6 (*March*, 1954).

Pb^{205} was sought as the daughter of Bi^{205} (which decays by electron capture to Pb^{205}); and in the deuteron irradiation of Tl. In each case the $\frac{1}{2}$-life is $\sim 10^6$ years, but the observed counts are only just of statistical significance. A. O. STANESBY

539.163.1

5895. The half life of long-lived Kr^{85}. J. F. TURNER. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. N/R* 1254, 4 *pp.* (1953).

The use of a thin-lens β-spectrometer with a scintillator detector as a high-stability counting equipment is described. A repetitive accuracy in counting rate of 0·04 is achieved. Observation of the decay of Kr^{85} over a period of six months results in a half-life value of $10{\cdot}57 \pm 0{\cdot}14$ yr. A.

539.163.1

5896. The half life of curium 242. K. M. GLOVER AND J. MILSTED. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. C/R* 1373, 6 *pp.* (1954).

The half-life of Cm^{242} has been re-determined by accurate α-counting of a pure curium source over a period of seven months. After allowing for the growth of the Pu^{238} daughter, the value obtained is 162·46 days, in very close agreement with the accepted value of $162{\cdot}5 \pm 2$ days, but the precision has been greatly improved. The standard deviation in half-life from the present results is $\pm 0{\cdot}27$ days. A.

539.163.2

5897. A study of the radioactivity of Sb^{125}_{51}. J. MOREAU. *Ark. Fys.*, **7**, *Paper* 30, 391–7 (1953) *In French.*

Measurements were made of the β- and γ-spectra of Sb^{125}, and also of the β–γ, γ–γ, and e^-–γ coincidence spectra. A consistent level scheme is put forward. A. O. STANESBY

539.163.2

5898. The decay of ^{173}Hf. A. H. WAPSTRA AND C. JONGEJANS. Letter in *Physica*, **20**, 36 (*Jan.*, 1954).

Results are given of NaI(Tl) scintillation spectrometer measurements of the X- and γ-radiation of Hf^{173}, obtained by irradiating Yb with 56 MeV α-particles. A. O. STANESBY

539.16

5899. The decay of 193 osmium. H. DE WAA Letter in *Physica*, **20**, 41–3 (*Jan.*, 1954).

The β-particle and conversion electron spectra Os^{193} were examined in detail both alone and coincidence, and compared with earlier results. disintegration scheme is proposed. A. O. STANE

539.16

5900. On the disintegration of radium. R. R. R AND M.-L. GOES. *C.R. Acad. Sci.* [*Paris*] **238**, 469– (*Jan.* 25, 1954) *In French.*

Conversion electrons associated with the d integration of Ra were examined in a cloud-chamb using a freshly-separated source of Ra. Electro were found corresponding to conversion of γ-rays 188 ± 10 (K, $L+M+N$) and 663 keV (K). T relative intensities are consistent with a spin of 2 the 1st excited state of Rn^{222}. A. O. STANES

539.163

5901. Angular correlation of α-particles and co version electrons in the disintegration of radiu R. R. ROY AND M.-L. GOES. *C.R. Acad. Sci.* [*Par* **238**, 581–3 (*Feb.* 1, 1954) *In French.*

This was measured for the 188 and 663 keV co version electrons, using a diffusion cloud chambe The results are in agreement with an angul momentum of 2 for both the 1st and 2nd excite states of Rn^{222} (see also preceding abstract).

A. O. STANESB

539.163

5902. Radioactive Si^{31}. W. S. LYON AND J. MANNING. *Phys. Rev.*, **93**, 501 (*Feb.* 1, 1954).

One γ-ray of energy 1·26 MeV is found to accom pany 0·07% of the disintegrations of Si^{31}. Th thermal neutron atomic activation cross-section fo the reaction $Si^{30}(n,\gamma)Si^{31}$ is observed to be $2{\cdot}9 \pm$ 0·3 millibarn.

539.163.

5903. Decay of V^{52}. J. M. LEBLANC, J. M. CORK S. B. BURSON AND W. C. JORDAN. Letter in *Phys Rev.*, **93**, 1124 (*March* 1, 1954).

A scintillation counter and β-spectrometer i coincidence were used to show that 3·75 min V^5 decays by a β-ray ($E_{max} = 2{\cdot}6$ MeV) followed by single γ-ray ($1{\cdot}44 \pm 0{\cdot}02$ MeV). No evidence fo the 2·6 min or 16 hr activities was found.

M. A. GRAC

539.163.2

5904. Short-lived metastable states of W^{182}. A. W SUNYAR. Letter in *Phys. Rev.*, **93**, 1122 (*March* 1 1954).

Delayed coincidence measurements with scintilla tion counters and pulse-height selectors, using a source of Ta^{182}, show that a state of $\frac{1}{2}$-life $1{\cdot}02 \pm 0{\cdot}05\times10^{-9}$ sec precedes most of the hard γ-rays of W^{182} and that the 100 keV γ-ray ($E2$) has a $\frac{1}{2}$-life of $1{\cdot}27 \pm 0{\cdot}10\times10^{-9}$ sec. M. A. GRACE

539.163.2

5905. The decay of Ho^{166}. A. W. SUNYAR. *Phys. Rev.*, **93**, 1345–7 (*March* 15, 1954).

The disintegration of Ho^{166} (27·3 hr) has been studied by scintillation counter coincidence techniques.

rays of 1·53 MeV and 1·61 MeV are present low intensity, in addition to the previously entified 80 keV and 1·36 MeV transitions. Both e 1·36 MeV and the 1·53 MeV γ-rays are in coinci-ence with the 80 keV transition. For the 80 keV 2 transition the K-conversion coefficient has been easured as $1·9 \pm 0·2$ and the total conversion efficient as $7·6 \pm 1·5$. The β-branching has been etermined from $\beta - \gamma$ and $\gamma - \gamma$ coincidence easurements and by a comparison of the $\beta - \gamma$ incidences with Tm^{170}. The results indicate a round state branch of ~25%, a branch of ~74% the 80 keV state, a branch of ~1% to a state at ·44 MeV and a branch of ~0·3% to a state at ·61 MeV in Er^{166}. The spin of Ho^{166} is probably —. A.

539.163.2

5906. The disintegration of Mo^{99}. J. Varma and E. Mandeville. *Phys. Rev.*, **94**, 91–4 (*April* 1, 1954).

The radiations of Mo^{99} and Tc^{99m} have been re-nvestigated by means of scintillation spectroscopy. Employing single-channel pulse-height analysers in coincidence, it has been established that a triple cascade of γ-rays, 741 keV → 41 keV → 140 keV occurs. The 741 keV radiation is also coincident with a γ-ray at 181 keV by an alternate branch of de-excitation which is equally probable. Radiation at 780 keV is present but is non-coincident with other γ-rays. From these data, a disintegration scheme can be constructed. A γ-ray of energy 372 keV was also detected, and, although it appeared to have the proper half-period to be associated with Mo^{99}, was found to be not in immediate coincidence with β-rays or other γ-rays, suggesting that it might be related to an impurity. A.

539.163.2

5907. The decay scheme of Zr^{95}. P. S. Mittelman. *Phys. Rev.*, **94**, 99–102 (*April* 1, 1954).

The decay scheme of Zr^{95} has been studied using the techniques of β-ray spectroscopy and β-γ angular correlation. The decay of Zr^{95} is found to proceed by three β-γ cascades. Two of the β-transitions are allowed and proceed to Nb^{95} levels at 722·0 keV and 754·4 keV. The third β-transition is to a 235 keV level in Nb^{95}. From K-conversion coefficient determinations and shell theory the 722 keV and 754·4 keV levels are both assigned even parity and a spin of 5/2 or 7/2. A.

539.163.2

5908. Decay of $_{65}Tb^{160}$ (71 day). S. B. Burson, W. C. Jordan and J. M. LeBlanc. *Phys. Rev.*, **94**, 103–9 (*April* 1, 1954).

By means of 180° internal-conversion electron spectrometers and the scintillation coincidence spectrometer, the radiations of $_{65}Tb^{160}$ (71 day) have been studied. In addition to many of the previously reported transitions in Dy^{160}, three new γ-rays of 0·759, 1·17 and 1·26 MeV are observed. By using the energy values determined from the internal conversion studies together with β-γ and γ-γ-coincidence results a decay scheme is deduced which is consistent with the experiments discussed. A.

539.163.2

5909. The nuclear spectra of Ce^{144} and Pr^{144}. W. S. Emmerich, W. J. Auth and J. D. Kurbatov. *Phys. Rev.*, **94**, 110–12 (*April* 1, 1954).

The nuclear spectra of Ce^{144} and Pr^{144} have been studied with magnetic and scintillation spectrometers. The 304 keV β-transition of Ce^{144} was found to be 70·5% abundant from a Kurie plot analysis. For the β-spectra leading to the 134 keV and 81 keV levels, intensities of 22% and 3% were obtained, respectively, from internal conversion and γ-ray data. An energy level of 175 keV in Pr^{144} was inferred from energy balance considerations. The relative intensities of the Pr^{144} β-transitions were determined from the abundance of the 695 keV γ-transition in Nd^{144} which was found to be $1·25 \pm 0·2\%$. A spin of one and odd parity appears plausible for the 2185 keV level in Nd^{144}. A.

539.163.2

5910. Potassium-44. B. L. Cohen. *Phys. Rev.*, **94**, 117–18 (*April* 1, 1954).

Potassium-44 was produced by an (n, p) reaction on calcium and found to decay by negatron and γ-emission with a $22·0 \pm 0·5$ min half-life. The identification was ascertained by comparison of yields from normal and isotopically enriched calcium, cross-section measurements, chemical processing and investigation of impurity effects. The β-ray spectrum is quite complex but includes strong components with maximum energies of about 4·9 and 1·5 MeV. The γ-ray spectrum includes strong gammas at 1·13, 2·07 and 2·48 MeV, and a probable 3·6 MeV gamma. A.

539.163.2 : 539.172.4

5911. Transcurium isotopes produced in the neutron irradiation of plutonium. S. G. Thompson, A. Ghiorso, B. G. Harvey and G. R. Choppin. Letter in *Phys. Rev.*, **93**, 908 (*Feb.* 15, 1954).

Starting with Pu, successive neutron capture and β-decay processes yield isotopes of Bk, Cf and element 99, identified by ion exchange methods. The following mass assignments and modes of decay are suggested: Bk^{249} (soft β-particles), $Cf^{>248}$ (6·15, 6·05, 5·8 MeV α-particles) and 99^{253} (6·6 MeV α-particles). M. A. GRACE

539.163.2 : 539.172.4

5912. Further production of transcurium nuclides by neutron irradiation. B. G. Harvey, S. G. Thompson, A. Ghiorso and G. R. Choppin. Letter in *Phys. Rev.*, **93**, 1129 (*March* 1, 1954).

See preceding abstract. Neutron irradiation of Cf leads to an α-emitting isotope ($E = 7·2$ MeV, ½-life ~3·6 hr) of element 100, identified by its position in the elution sequence from an ion exchange column and tentatively assigned to mass number 254. M. A. GRACE

539.164 : 539.152.1

5913. The strong surface coupling nuclear model and hindered alpha decay. J. O. Rasmussen, Jr. *Ark. Fys.*, **7**, *Paper* 16, 185–8 (1953).

Alpha-decays such as $Am^{241} \rightarrow Np^{237}$ should go fairly rapidly according to the shell model, but are found to be highly hindered. The strong surface

coupling model of A. Bohr opens the possibility that the odd protons, although giving rise to the same nuclear spin in different nuclei, may have quite different wave functions, resulting in a low transition probability. G. E. BROWN

539.164.08

5914. The problem of α-particle counting in 50% geometry. E. COTTON, A. LÉVÊQUE AND R. COHEN. *J. Phys. Radium*, **15**, 109–17 (*Feb.*, 1954) *In French.*

A method is described of determining accurately the correction for self-absorption by thin layers of α-emitters in 2π-geometry. Back-scattering by the source support may introduce an uncertainty of the order of 1% in the measurement of absolute α-activities. A. O. STANESBY

539.164.08

5915. Absolute alpha standardization with liquid scintillators. J. K. BASSON AND J. STEYN. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 297–8 (*March*, 1954).

The α-particle emitter is dissolved in 2·5-diphenyloxazole in *p*-dioxane (3 g/l) with 3% water present, and scintillations are observed with a RCA 5819 photomultiplier. Extrapolation to zero bias gives the absolute disintegration rate of the sample. G. F. J. GARLICK

539.165

5916. β-spectrum of RaE in the low energy region. J. PNIEWSKI. *Acta phys. Polon.*, **11**, *No.* 3–4, 215–25 (1951–52).

Electron-sensitive nuclear research emulsion was used as an electron detector in a magnetic-lens spectrograph for the investigation of the β-spectrum of RaE in the low-energy region. The intensities were found by counting of some 35 000 separate electron tracks. Very thin sources were prepared by a volatilization method. The images obtained in the spectrograph were checked by a special method to prove the uniformity of the specific surface activity of the sources used. The spectrum was investigated within the energy band from 100 keV down to 4·6 keV. The results show that the energy distribution corresponding to this forbidden transition cannot be expressed simply in terms of $(E - E_0)^4$. It seems that the energy-distribution curve cuts the $P(E)$ co-ordinate. A.

539.165

5917. On the electron spectra of ^{232}Pa ^{233}Pa and ^{230}Pa. ONG PING HOK AND G. J. SIZOO. *Physica*, **20**, 77–84 (*Feb.*, 1954).

Measurements of the β-spectra of the Pa-isotopes, formed by deuteron bombardment of Th have been performed in a 30·0 cm double focusing β-spectrometer. The Fermi–Kurie analysis of the continuous spectra led to 5 partial spectra in Pa^{232} with end-points at 1·24, 0·715, 0·54, 0·37 and 0·26 MeV. The analysis of the spectrum of Pa^{233} led to 4 components, but is less certain because of the possible influence of Pa^{230}. A weak position spectrum was also detected. About 100 conversion lines could be detected, from which 35 γ-rays could be deduced. Fifteen of these γ-rays belong to Pa^{232}, 14 to Pa^{233} and 4 probably to Pa^{230}. For Pa^{232} a preliminary decay scheme is proposed, fitting the 5 β-components and the more intense γ-rays. The data for Pa^{233} do not allow the construction of a consistent decay scheme.

539.1

5918. On the question of the emission of positive particles from P^{32}. P. WEINZIERL. *Z. Naturforsch.* **9a**, 69–72 (*Feb.*, 1954) *In German.*

An upper limit of 10^{-6} was found for the ratio positrons/electrons emitted from a source of P using a trochoidal spectrometer. An attempt to detect coincidences between the possibly short-lived positive particles and other ionizing particles, using a small 180° spectrometer, gave a negative result. J. HUGH

539.1

5919. A study of the electron-capture/β$^+$-ratio for Sc^{44}. H. LANGEVIN AND N. MARTY. Letter in *J. Phys. Radium*, **15**, 127–8 (*Feb.*, 1954) *In French.*

This was obtained by comparison with the corresponding ratio for Na^{22}, using scintillation counters to record the electromagnetic spectra of the two sources. The results ($P_e/p_+ = 0{\cdot}05 \pm 0{\cdot}15$ and $0 \pm 0{\cdot}1$ by two different methods) are in good agreement with the theoretical value of 0·04. [See also Abstr. 584 (1951).] A. O. STANESB

539.16

5920. Radiative electron capture of Fe^{55}, A^{37}, and Ni^{59}. W. S. EMMERICH, S. E. SINGER AND J. D. KURBATOV. *Phys. Rev.*, **94**, 113–17 (*April* 1, 1954).

The radiative electron capture spectra of Fe^{55}, A^{37} and Ni^{59} were studied with a scintillation spectrometer. The end-point energies were found to be 226 ± 10 keV, 815 ± 20 keV and 1065 ± 30 keV respectively. A method was devised to correct the experimental intensity distributions for distortions due to the Compton effect in the scintillation crystal. This was applied to the spectra of A^{37} and Ni^{59} above 320 keV. In this energy range, the experimental spectrum of A^{37} was found to agree with the calculated spectral shape. In the case of Ni^{59}, a dependence of the spectral shape on the type of transition could not be detected within present experimental limits. A

539.165

5921. Beta decay of Np^{238}. H. SLÄTIS, J. O. RASMUSSEN, JR AND H. ATTERLING. Letter in *Phys. Rev.*, **93**, 646 (*Feb.* 1, 1954).

The β-particle and conversion electron spectra of 2·1 day Np^{238} were reinvestigated using a precision double-focusing spectrometer and a high-transmission intermediate-image spectrometer. Two additional weak γ-rays (of 939 and 925 keV) were detected. The decay scheme is discussed; the data are insufficient to construct an unique one. A. O. STANESBY

539.165

5922. Beta-ray spectrum of Mg^{28}. J. L. OLSEN AND G. D. O'KELLEY. Letter in *Phys. Rev.*, **93**, 1125 (*March* 1, 1954).

Mg^{28} is separated in a carrier-free state and mounted as a source of strength 10^6 disintegrations/minute on a thin Zapon film. The electron spectrum in the range 100 to 3500 keV is examined and a Fermi plot shows two transitions. The observed Al^{28} spectrum

s an allowed shape beyond the Mg^{28} spectrum and maximum energy of 2878 ± 14 keV. An upper nit of less than 0·8% is set for transitions to the ound state. The Mg^{28} component of the Fermi ot is computed and has an allowed shape from 0 keV to the maximum energy which is found to be 9 ± 2 keV corresponding to a log (*ft*) value of 45 in disagreement with the previously reported lues. The Fermi analysis of the low-energy data is ecked using a carrier-free sample of Cs^{137}.

D. R. CHICK

539.165

923. The third forbidden beta spectrum of rubium 87. M. H. MacGregor and M. L. Wiedenbeck. *ys. Rev.*, **94**, 138–40 (*April* 1, 1954).

The use of thin-lens β-spectrometers has been tended to the measurement of an isotope of tremely low specific activity, rubidium 87. The Rb^{87} spectrum is third forbidden and not "unique." The ectrum gave a linear Kurie plot when the third rbidden tensor (or vector) correction factor was plied. The extrapolated value $E_{max} = 275$ keV greed well with the results of recent investigations. n extension of a recent measurement of the Rb^{87} alf-life was carried out with an enriched sample of b^{87}, and a value $T_{\frac{1}{2}} = 6{\cdot}2 \pm 0{\cdot}3 \times 10^{10}$ years was btained. A.

539.165 : 531.717

924. The best performance with beta gages. R. Zumwalt. *Nucleonics*, **12**, 55–8 (*Jan.*, 1954).

Expressions are given for ionization chamber esponses, sensitivities, accuracy of measurement and esponse times in β-radiation gauges used to measure hickness of samples by transmission and backcattering, and the concentrations of solutions by backscattering. L. R. SHEPHERD

539.165.08

925. The dosimetry of beta radiations. R. Loevinger. *Radiology*, **62**, 74–82 (*Jan.*, 1954).

The dosimetry of β-radiation from small sources is hown to depend on knowledge of the distribution of bsorbed energy round a point source; the difficulty f making a direct determination is discussed. quations are given for this distribution function rom measurements on very thin plane sources of β-emitting isotopes. Plots of theory and experiment re shown to agree closely. D. V. MABBS

539.165.08

926. Experimental techniques in beta-ray spectroscopy. II. C. S. Cook. *Nucleonics*, **12**, 43–7 (*Feb.*, 954).

For Pt I, see Abstr. 4897 (1954). Problems involved n the use of G.M. counters and scintillation counters, sed as detectors in β-ray spectrometers, are described. Methods of measuring and controlling the magnetic ields of spectrometers are briefly outlined.

L. R. SHEPHERD

539.165.2

927. Correction to the beta-decay nuclear matrix elements. M. Yamada. *Progr. theor. Phys.*, **10**, 245–51 (*Sept.*, 1953).

In the traditional theory of β-decay, the radial parts of the eigenfunctions of the electron which are divided by r^l (l's are orbital angular momenta) are put out of the integral symbols replacing r by ρ (nuclear radius), and the remaining integrals are arranged as nuclear matrix elements. In the presence of the Coulomb field, however, some of them deviate from constants appreciably in the nucleus, and it is hard to put them out of the integrals. In this paper the correction factors which include these eigenfunctions in the integral symbols are given, and their effect is discussed. A.

539.165.2

928. Theoretical reinvestigation of the β-spectrum of RaE. M. Yamada. *Progr. theor. Phys.*, **10**, 252–64 (*Sept.*, 1953).

The β-spectrum of RaE is reinvestigated, taking into account the finite de Broglie wavelength effect pointed out by Rose *et al.* and the correction to the nuclear matrix elements pointed out by the author, and it is shown that the conclusion of Petschek and Marshak that only the assumption of tensor + pseudoscalar, spin change 0–0, parity change yes, is able to explain the experimental results is incorrect. Taking into account the above two effects, many other assumptions can explain the experiments. The results are as follows: TP0–0 (tensor + pseudoscalar and spin change 0–0), ST1–0 and VA1–0 fit the experiments only with the finite de Broglie wavelength effect, A0–0 (including AP0–0) and VT1–0 require both effects, but VT1–0 seems too artificial. Other cases do not agree with experiment. A.

539.165.2

929. Upper bound of the pseudoscalar coupling constant in beta-decay. J. Fujita and M. Yamada. *Progr. theor. Phys.*, **10**, 518–24 (*Nov.*, 1953).

The allowed shape β-spectra of He^6 and B^{12} are investigated with the mixture of tensor and pseudoscalar interactions, and it is concluded the ratio of the pseudoscalar coupling constant to that of tensor must lie in the region $-55 < G_P/G_T < 19$. A.

539.165.2

930. Cross terms in allowed-shape β spectra. II. J. P. Davidson and D. C. Peaslee. Letter in *Phys. Rev.*, **92**, 1584–5 (*Dec.* 15, 1953).

For previous part, see Abstr. 721 (1954). A good possibility of finding the mixture of (S, V) terms in the β-decay interaction is afforded by the (0–0) transition of the ground state of Cl^{34} to that of S^{34} with a half-life of 1·5 seconds. G. E. BROWN

539.165.2

931. A β-decay energy systematics. K. Way and M. Wood. *Phys. Rev.*, **94**, 119–28 (*April* 1, 1954).

A β-decay energy systematics is presented which exhibits linear relations for disintegration energies between atoms (Z, N) and ($Z + 1$, $N - 1$) when plotted as a function of N keeping Z constant. Separate plots are necessary for odd and even values of A. The disintegration energy lines show marked discontinuities for $N = 50$, 82 and 126. There is also considerable indication of a discontinuity at $N = 28$, and in the region of $N = 20$ sharp changes in slope are observed. Proton magic numbers at 50, 82 and possibly 28 are indicated by gaps in the spacing of the disintegration energy lines. No definite submagic numbers are at present identifiable. Changes

in the even-odd differences of neutron and proton binding energies show up as changes in the line separation pattern. The most striking pattern changes can be interpreted as due to decreases in the even-odd differences for both neutrons and protons after their respective magic numbers. The systematics is useful in estimating disintegration energies in cases where measurements have not yet been made. Part of a systematics for double β-decay is also shown. A.

539.166

5932. Angular correlation of three successive gamma quanta. J. DABROWSKI. *Acta phys. Polon.*, **12**, *No.* 1, 64–75 (1953).

Formulae are given for the angular correlation of three successive γ-quanta. The assumption is made that each γ-quantum is of a given multipolarity. The z-axis is taken along the direction of propagation of the second quantum. The Racah summation formulae are used twice. The final correlation formula is given in terms of $P_{2\mu_1\lambda}(\cos\theta_1)P_{2\nu_3\lambda}(\cos\theta_3)\cos\lambda\phi$, where $\theta_1(\theta_3)$ is the angle between the direction of the first (third) and the second quantum, and ϕ is the dihedral angle between the planes of the first-second and third-second quanta. Numerical values of the correlation coefficients for dipole transitions are given. Results are given for the limitations of anisotropy. The formalism describes also the case in which some of the emission processes are replaced by absorption processes. A.

539.166

5933. The line shape of monochromatic γ-radiation in scintillation spectrometers. D. MAEDER, R. MÜLLER AND V. WINTERSTEIGER. *Helv. phys. Acta*, **27**, *No.* 1, 3–44 (1954) *In German.*

After a brief outline of the various effects governing the "line shape" (photopeak + continuum) in a scintillation spectrometer at energies of the order 1 MeV, the general equations for computing the energy distribution of scintillations produced by monochromatic incident γ-rays are established. A compilation of numerical data on the primary absorption and scattering in NaI (Tl) is given; extrapolation of measured photo fractions to zero crystal size seems to indicate that at 1 MeV the photoabsorption cross-section might be appreciably smaller than predicted by Hulme *et al.* In the evaluation of the theoretical Compton distribution for an infinitely large crystal, perpendicular incidence of the primary quanta is assumed; secondary and tertiary absorption and scattering have been calculated rigorously and higher order effects taken into account by an approximate procedure. To simplify calculations for finite cylindrical crystals, it is assumed that γ-rays enter the crystal only along the cylinder axis, but corrections for the case of bad collimation are developed. Curves show the modified Compton distribution and photo fraction for NaI crystals with $L = R = 0{\cdot}5$ cm, 1 cm, 2 cm, 4 cm, ∞ at different energies from 0·255 to 1·28 MeV. The corrections for γ-rays scattered from outside into the crystal, by pair creation (which proves negligible, as far as the apparent photo fraction is concerned, up to 2 MeV), and by bremsstrahlung and range losses are discussed. The latter, as well as the hard component of the collimator scattering, become appreciable abo 1 MeV, whereas the soft component produced by t collimator may be eliminated by characteris absorbers. Experimental applications include t verification of the calculated photo fraction as function of energy and crystal size, absolute γ-r intensity measurements and analysis of complex li spectra such as those produced by Ga^{67}, In^{114} a Au^{198}.

539.1

5934. Continuous and discrete gamma-radiation the decay of ^{103}Pd. L. H. T. RIETJENS, H. J. VAN D BOLD AND P. M. ENDT. *Physica*, **20**, 107–14 (*Fe* 1954).

The continuous γ-ray spectrum (internal brem strahlung) and the discrete γ-rays resulting from t decay of Pd^{103} by electron capture were investigat with a scintillation spectrometer. Weak discr γ-rays were found with the following energies a intensities: 503 ± 8 keV (0·11 ± 0·002%), 367 6 keV (0·60 ± 0·007%), 305 ± 8 keV (0·11 ± 0·003 and (262 ± 15) keV (0·04 ± 0·002%). The co tinuous spectrum was observed, but accurate dete minations of its endpoint, intensity and shape we made difficult by the presence of the discrete γ-ra From an analysis of observed *ft*-values the Pd spin and parity can be determined as $J = \frac{5}{2}^+$ a the Pd^{103}–Rh^{103} mass difference as (557^{+27}_{-12}) keV.

539.1

5935. On the 620 keV γ-radiation of $^{80}_{35}$Br. LABERRIGUE-FROLOW, H. LANGEVIN AND R. BERNA *C.R. Acad. Sci.* [*Paris*] **238**, 677–8 (*Feb.* 8, 1954) *French.*

A further examination of the γ-radiations of Br [Abstr. 5029 (1953)] indicate the presence of th 620 keV γ-ray found by Scharff-Goldhaber a McKeown [Abstr. 1617 (1954)]. A. O. STANESB

539.1

5936. The disintegration of cobalt 57. D. H ALBURGER AND M. A. GRACE. Note in *Proc. Phy Soc.* [*London*] *A*, **67**, 280–3 (*March*, 1954).

The radiations were examined in a Xe-fille proportional counter; the 2 γ-rays (γ_1, γ_2) hav energies 138 ± 1 and 123 ± 1 keV. From th internal conversion coefficients these are respectivel quadrupole and dipole (probably *E*2 and *M*1).

A. O. STANESB

539.16

5937. Isomerism in ^{46}Ti. H. S. MURDOCH AN A. J. WEBB. Note in *Proc. Phys. Soc.* [*London*] *A* **67**, 286–8 (*March*, 1954).

The γ-radiation from Sc^{46} was examined using delayed coincidence technique. No $\frac{1}{2}$-life exists wit $\tau > 10^{-6}$ sec [cf. 12·15 μsec $\frac{1}{2}$-life found by Na *et al.*, Abstr. 6407 (1951)]. A. O. STANESB

539.166.0

5938. The measurement of γ-radiation from th human body. D. TAYLOR, J. RUNDO, P. G. JENSEN O. M. HENRIQUES AND F. WADE. *Atomic Energ Res. Establ.* [*Harwell*] *Rep. EL/R*1250, 5 *pp.* (1953).

Describes an assembly of high-pressure ionizatio chambers 7 ft long, capable of measuring 0·1–5 μC and arranged so that a stretcher carrying a patien

travel horizontally beneath them. Water shielding used, and background radiation is balanced by ng compensating chambers and measuring the ference current. Diagrams show calibration of the tem with a 0·5 μC Th sample. Results obtained m normal persons are given. Sensitivity is of the ne order as for the Spiers and Burch apparatus. A ggestion for using large Geiger counters working anti-coincidence may be followed to obtain higher nsitivities. D. V. MABBS

539.166.08

39. Analysis of radiation fields of two gamma-diation sources. J. G. LEWIS, J. V. NEHEMIAS, D. E. ARMER AND J. J. MARTIN. *Nucleonics*, **12**, 40–4 *an.*, 1954).

The dose rates in and about hollow cylindrical Co^{60} urces are calculated. Measurements made with rrous sulphate dosimeters and ionization chambers the dose rates from 1 and 10 kilocurie sources dicated that these were low by a factor of more an 3. It is suggested that the actual activities of e sources might be lower than the nominal values, ue to local depression of the neutron flux in the pile uring irradiation of the sources. L. R. SHEPHERD

539.166.08

940. Density effect in gamma-ray measurements. . N. WHYTE. *Nucleonics*, **12**, 18–21 (*Feb.*, 1954).

The corrections which must be applied to cavity-hamber measurements of γ-radiation, due to the act that the stopping power for charged particles is ss for the closely packed atoms of a solid than for he dispersed atoms of a gas, are calculated for various vall materials (graphite, polystyrene, lucite, bakelite nd Al) and for γ-rays of various energies (I^{131} to Na^{24}). When corrections are applied to measurements n Ra(B + C) γ-rays, it is found that the dose rate s 8·2 r per mg per hr at 1 cm in good agreement with Taylor and Singer's free air value (8·16 r per ng per hr at 1 cm). L. R. SHEPHERD

539.166.2

5941. Directional correlation for two-quanta emis-sion. W. KRÓLIKOWSKI. *Acta phys. Polon.*, **11**, *No.* 3–4, 233–55 (1951–52).

Contains correlation formulae for directions of two photons emitted simultaneously in a single act of two-quanta emission. The formulae apply to electric double-dipole radiation, i.e. where both photons are of electric dipole type. Especially interesting is the transition $j' = 0 \rightarrow j = 0$ forbidden for one-quantum emission. The forms of matrix elements obtained in the course of the calculations are useful not only for the electric dipole moment but also for a wider class of vectors, including among others the magnetic dipole moment. Measurements of directional correlations of photons are admittedly possible by γ-radiation. Therefore the present paper refers to two-quanta emission from the nucleus, although the arguments equally apply to any system of charged particles. Moreover, the results are applicable after a slight and obvious change of coefficients to other simultaneous processes of second order (in double-dipole approximation) such as for instance the Raman effect. A.

539.166.2

5942. Mixed gamma-mixed gamma angular correlation. M. E. ROSE. *Phys. Rev.*, **93**, 477 (*Feb.* 1, 1954).

The γ-γ correlation in which both radiations are mixed, with arbitrary admixture ratios, is discussed. A.

539.166.74 : 537.531

5943. Anomalous X-ray scattering of heavy atoms in the region of the *K*- and *L*-edges according to the wave-mechanical dispersion theory. I. H. EISENLOHR AND G. L. J. MÜLLER. *Z. Phys.*, **136**, *No.* 5, 491–510 (1954) *In German.*

Expansions in spherical harmonics and in the ratio of the *L*-shell radius to the X-ray wavelength are carried out, and the probability of coherent scattering by *L*-shell electrons is calculated inclusive of the first few terms in each series. Coulomb intermediate states are employed. G. E. BROWN

539.166.74 : 537.531

5944. Anomalous X-ray scattering of heavy atoms in the region of the *K*- and *L*-edges according to the wave-mechanical dispersion theory. II. H. EISENLOHR AND G. L. J. MÜLLER. *Z. Phys.*, **136**, *No.* 5, 511–33 (1954) *In German.*

The formalism of Pt I is applied to the calculation of the anomalous dispersion and absorption of γ-rays in heavy atoms. For tungsten and tellurium, curves of dispersion and absorption *v.* energy are given for γ-rays with energy in the region of the *K*- and *L*-absorption edges, and the angular dependence of the scattered γ-rays are calculated at three energies for tellurium. The photo-absorption curves are in good agreement with experiment. G. E. BROWN

539.166.74

5945. Internal Compton effect in Ba^{137}. L. SPRUCH AND G. GOERTZEL. Letter in *Phys. Rev.*, **93**, 642 (*Feb.* 1, 1954).

The angular distribution of continuous γ-rays given off by the electron during internal conversion is calculated by Born approximation. G. E. BROWN

539.166.74

5946. The backscattering of the Co^{60} gamma rays from infinite media. E. HAYWARD AND J. H. HUBBELL. *J. appl. Phys.*, **25**, 506–9 (*April*, 1954).

The radiation backscattered by semi-infinite slabs of wood and steel wool, when irradiated by the Co^{60} γ-rays, has been investigated by means of a sodium iodide scintillation spectrometer. The main contributions to the scattered radiation are produced in one or two Compton collisions. However, the radiation that has suffered so many collisions as to have an isotropic angular distribution has also been observed. A.

539.166.83

5947. On the spectral distribution of internal bremsstrahlung emitted by ^{32}P and ^{90}Y. B. MAKIEJ. *Acta phys. Polon.*, **12**, *No.* 1, 32–44 (1953).

Absorption curves of weak γ-radiation emitted by P^{32} and Y^{90} and absorbed in lead were taken with the help of a scintillation counter acting as a detector of high efficiency. The absorption curves obtained on experimental data were analysed and compared with absorption curves calculated on the basis of spectral

distribution of internal bremsstrahlung according to Knipp and Uhlenbeck's theory. The results of experiments and calculation lead to the following conclusions: (1) the spectral distribution of internal bremsstrahlung of P^{32} calculated on theoretical grounds agrees with experimental results, (2) in the case of Y^{90} a spectrum of hard γ-radiation of about 1·5 MeV energy and about 5 photons per 10 000 β-transitions intensity is superimposed on the internal bremsstrahlung spectrum. A.

539.166.83

5948. Internal conversion of the zero-zero transition in RaC′. D. E. Alburger and A. Hedgran. *Ark. Fys.*, **7**, *Paper* 35, 423–5 (1954).

The conversion electron spectrum corresponding to the 1·42 MeV transition of RaC′ was examined at high resolution in a 50 cm radius double-focusing spectrometer. The results are in good agreement with the theoretical predictions of Drell for zero-zero transitions. A. O. Stanesby

539.166.835

5949. On the dependence of the cross-section for pair production on the atomic number *Z*. A. Z. Hrynkiewicz. *Acta phys. Polon.*, **11**, *No.* 3–4, 263–72 (1951–52).

The ratio of the cross-section for production of electron pairs by γ ThC″ rays (2·62 MeV) in Al, Cu and Ag to the cross-section in Pb was measured. For this purpose the G.M. counter method was employed, using counters for β-rays working in coincidence. Possible sources of errors, the most important among which are due to Compton coincidences caused by a Compton electron and a scattered γ-photon, were carefully considered and discussed. The ratio of the cross-sections in Al and Pb was found to be much larger than the ratio theoretically calculated from Bethe and Heitler's and Jaeger and Hulme's theories. A.

539.166.835

5950. Theory of bremsstrahlung and pair production. II. Integral cross section for pair production. H. Davies, H. A. Bethe and L. C. Maximon. *Phys. Rev.*, **93**, 788–95 (*Feb.* 15, 1954).

The differential cross-section for bremsstrahlung and pair production at high energies obtained in the preceding paper by Bethe and Maximon [Abstr. 4604 (1954)] has been integrated over all angles, and formulae are given for the integral cross-section for all Z. For small Z, the correction to the Born approximation is proportional to Z^2, and the constant of proportionality is given. The correction for heavier elements is somewhat less than the Z^2 law would indicate. It is shown that the correction is associated only with large recoil momenta of the nucleus whereas screening is important only for small recoil momenta; and, therefore, the same correction is valid in the case of complete, incomplete, or no screening. Agreement of these new predictions with observations of pair-production cross-section at 88 and 280 MeV is excellent and not unreasonable at 17·6 MeV. A.

539.166.835 : 537.533.8

Limits of applicability of the theory of bremsstrahlung electrons and pair production for high energies. *See Abstr.* 5696

539.166.835 : 537.59

Angle of divergence of pairs produced by photo *See Abstr.* 5782

539.169 :

Some effects of high energy radiation on glass. *Abstr.* 6209

NUCLEAR REACTIONS 539.17

539.1

5951. Angular correlation in a three-stage nucl reaction. M. J. Brinkworth. *Atomic Energy R Establ.* [*Harwell*] *Ref. GP/R*1364, 3 *pp.* (1954).

General formulae are derived for angular corre tions in three-stage nuclear reactions in which int ference occurs due to overlapping excited states of t intermediate nuclei.

539.1

5952. Symmetry correlations in nuclear reactio A. Gamba. Letter in *Nuovo Cimento*, **11**, 323 (*March*, 1954).

A correlation exists between the spatial sp polarization and the isotopic spin polarization nuclear reactions. This is demonstrated in the ca of the splitting of He^3 into two protons and a neutro Various states are classified according to P, P' and P (the partition numbers of Wigner); the total spati spin S and the isotopic spin T. G. E. BROW

539.1

5953. Distributions, angular correlations, and energ distributions of the tracks in stars of nuclear disintegr tions produced from cosmic radiation. G. Bellibo and B. Vitale. *Nuovo Cimento*, **11**, 372–92 (*Apr* 1954) *In Italian.*

The angular distributions and angular correlatio of the low, average and high energy prongs in nuclea disintegration stars produced by the cosmic radiatio in nuclear plates are analysed for 585 low and averag energy stars and 95 high energy stars. For eac group of stars, the distribution in space of the angles between the prong and the vertical or the primary and ψ, between two prongs, are given. For the hig energy stars the energy spectrum is also given. Th whole of the observed phenomena allow a phenc menological picture to be collected of the informatio about the nuclear disintegrations, obtainable fro angular and energetic analyses of the prongs. In littl stars, without visible recoil tracks, the large anisotrop and the excess of large angles between prongs may b ascribed to the disintegrations of light nuclei; i average energy, without visible recoils, the anisotrop and the excess of correlations at 90° between th prongs are due to the knock-on prongs. On the othe hand, the low and average energy stars, with visibl recoils, show angular distributions nearly isotropic In high energy stars, the anisotropy of the "black' prongs becomes practically constant when the energy of the primary increases, while that of one of the "sparse-black" and "grey" prongs becomes more isotropic. These features of the high-energy disinte grations are attributed to a shift of all the prongs of the nucleonic cascade toward larger energies; the

dual anisotropy of the black prongs being due to ie new phenomena, such as local evaporation of nuclear surface. The energy spectrum of the iest energy stars shows a secondary maximum for ~ 100 MeV; any interpretation of it in terms of on reabsorption or pick-up process being excluded. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 0–83

539.172

4. The interaction cross section of hydrogen and vier elements for 450-MeV negative and 340-MeV itive pions. S. J. LINDENBAUM AND L. C. L. YUAN. ter in *Phys. Rev.*, **92**, 1578–9 (*Dec.* 15, 1953).

The π^+ or π^- beam from the Brookhaven motron was used and momentum analysed by a ective triple monitor telescope with a deflecting gnet between the second and third counters with ans for giving quadrupole coincidence in these ee counters (diphenolacethylene crystals) and a ge liquid scintillator behind polyethylene, carbon copper absorbers. The total measured interaction oss-section for a 450 MeV π^--beam (containing % μ^- and electrons) yielded an approximate erage cross-section per nucleon as: hydrogen ± 3 mb; carbon 26 ± 4 mb; copper 25 ± 5 mb. mparison of the results with those of Anderson, rmi *et al.*, which gave 60 ± 6 mb at 216 MeV, dicated a fairly sharp, probably resonance-inter- tion, peak in the energy-dependence curve of $\pi^- \rightarrow p$. The π^+ interaction cross-section at 0 MeV was determined to be 48 ± 9 mb, again a crease on the values of Anderson and Fermi of 5–150 mb at 135 MeV. D. R. CHICK

539.172.11

55. Coulomb excitation of heavy and medium avy nuclei by [3 MeV] alpha-particles. G. M. EMMER AND N. P. HEYDENBURG. Letter in *Phys. ev.*, **93**, 354 (*Jan.* 15, 1954).

Preliminary report of extensive study of ~50 ele- ents in 30 of which excited states below 500 keV ere observed. Energies and intensities of the rays observed with an NaI(Tl) crystal are listed. W. J. SWIATECKI

539.172.11

956. Coulomb excitation of [19] heavy and medium avy nuclei by alpha particles. II. N. P. HEYDENBURG ND G. M. TEMMER. Letter in *Phys. Rev.*, **93**, 906 *Feb.* 15, 1954).

Continuation of survey (preceding abstract). No efinite evidence for transitions higher than quadru- ole. In odd-A nuclei 9 cases were found in which simple rotational interpretation seems excluded pin of excited state < spin of ground state). W. J. SWIATECKI

539.172.13

957. Nuclear cross sections at low energies. J. L. OHNSON AND H. M. JONES. *Phys. Rev.*, **93**, 1286–91 *March* 15, 1954).

The note is concerned with estimates of the accuracy f the one-term formula for the energy dependence of ne reaction cross-section for charged particles. The second term in an expansion of the cross-section in powers of the energy is worked out for a one-body model. Comparison with data of Sawyer and Phillips on the bombardment of Li and Be with protons and deuterons show that the deviations from the one-term formula are of the correct order of magnitude to be accounted for by the second term. This term was compared with the effect of the 107 keV resonance on the cross-section of $H^3(d, n)He^4$. Employing a conservative central-field model the correction term to the one-body asymptotic form is found to be smaller than the effect of the resonance expected from the Breit–Wigner formula. The f-function generalization to $L > 0$ which has been made by Breit is studied and a table facilitating its use for the calculation of reaction cross-sections is given. A.

539.172.13

5958. The ranges of fragments from high-energy fission of uranium. E. M. DOUTHETT AND D. H. TEMPLETON. *Phys. Rev.*, **94**, 128–37 (*April* 1, 1954).

The ranges in aluminium of several fragments from the fission of U^{238} induced by 18 MeV deuterons and by 335 MeV protons have been measured by a radiochemical method. The ranges found are of the same order of magnitude as those reported for slow-neutron-induced fission. The difference in the forward and backward recoil ranges in the deuteron (18 MeV) case is consistent with the momentum corresponding to compound nucleus formation. The ranges found in the proton (high-energy) case are shorter than those of the deuteron case, the differences being greater for the lighter fragments. These differences are explained by the change in mass of the complementary fragments due to evaporation of neutrons prior to fission in the proton case, which causes the observed fragment to receive a smaller fraction of the total kinetic energy. A.

539.172.13

5959. Coulomb corrections in stripping. S. T. BUTLER AND N. AUSTERN. Letter in *Phys. Rev.*, **93**, 355 (*Jan.* 15, 1954).

The calculation is carried through numerically for the particular case of 8 MeV deuterons incident on a nucleus of $Z \simeq 15$, $l = 2$ protons being captured. Polarization of the deuteron is neglected. In this case the Coulomb effects do not change the previous results essentially. G. E. BROWN

539.172.13 : 539.152.1

5960. Proton groups from deuteron bombardment of Ne^{20} by magnetic analysis. Transitions to the ground state and first excited state of Ne^{21}. K. AHNLUND. *Ark. Fys.*, **7**, *Paper* 14, 155–63 (1953).

Results give $Q_0 = 4{\cdot}526 \pm 0{\cdot}009$, $Q_1 = 4{\cdot}177 \pm 0{\cdot}009$ MeV for the 2 proton groups of longest range in the reaction $Ne^{20}(d, p)Ne^{21} + Q$; the energy of the 1st excited level of $Ne^{21}(= Q_0 - Q_1)$ is $0{\cdot}349 \pm 0{\cdot}006$ MeV. A. O. STANESBY

539.172.13 : 539.167.3

5961. The production of Na^{22} by A (H^3, n) reaction in a nuclear reactor. L. G. COOK AND K. D. SHAFER. *Canad. J. Chem.*, **32**, 94–7 (*Feb.*, 1954).

The positron-emitting Na^{22} of 2·6 yr half-life has been prepared in a nuclear reactor by the double reaction $Li^6(n, \alpha)H^3$, $Ne^{20}(H^3, n)Na^{22}$. The over-all

yield was $2{\cdot}3\times10^{-7}$ atoms of Na^{22} per atom of tritium formed. Eleven grams of lithium as aluminium alloy turnings in a neon atmosphere at 200 lbs/in². was irradiated for 175 days in a neutron flux of about 4×10^{12} n./cm².sec. About 380 μc of Na^{22} was obtained in a sodium extract having a specific activity of 10 mc Na^{22}/g of Na^{23}. A specific activity in the curie/g level would be expected from a longer irradiation in the highest flux (6×10^{13} n./cm².sec) in the NRX reactor. The separation and purification of the sodium proved practicable by paper chromatography or ion exchange; the analyses for trace Li and Na^{23} were carried out by radioactivation. A.

539.172.13 : 523.877

5962. The $He^3 + He^3$ reactions. W. M. Good, W. E. Kunz and C. D. Moak. *Phys. Rev.*, **94**, 87–91 (*April* 1, 1954).

A study has been made in the energy range up to 800 keV of He^3 capture on He^3 and the reactions that accompany this capture. The proton energy spectrum was found to confirm an earlier observation that the capture is followed by two modes of disintegration, viz. into two protons and an α-particle, and into a proton and Li^5. Improved resolution and statistics give no evidence of well-defined groups of protons of energy less than the Li^5 ground-state group. The total reaction cross-section was observed to rise monotonically in a manner suggesting partial waves of l greater than one. At 200 keV the cross-section is at least 2·5 microbarns, substantiating the fact that the capture of He^3 on He^3 is the dominant reaction terminating the $p-p$ cycle for stellar production of energy. A.

539.172.3

5963. The (γ, n) reaction of molybdenum produced by the Li(p, γ) γ-rays. S. Shimizu, S. Yasumi, Y. Saji and J. Muto. *Mem. Coll. Sci. Univ. Kyoto A*, **26**, 85–96 (*Oct.*, 1950).

The radioactivities induced in molybdenum samples were measured precisely by an end-window type β-ray counter with a thin mica window. The absolute number of γ-ray quanta was determined by a specially constructed Geiger–Müller counter with a thick lead wall, of which counting efficiency was computed theoretically. By measuring the intensities of activities produced in a set of molybdenum samples of various thickness and the number of γ-ray quanta concerned, the apparent cross-section of this reaction was obtained for the sample with different thickness. Extrapolating the curve of apparent cross-section v. the thickness of irradiated sample to zero thickness, the absolute cross-section of the $Mo^{92}(\gamma, n)Mo^{91}$ reaction was determined for the Li(p, γ) γ-rays as $9{\cdot}9\times10^{-26}$ cm². The results obtained are discussed. A.

539.172.3 : 539.185

5964. Energy spectra and angular distributions of photoneutrons from heavy nuclei. G. A. Price. *Phys. Rev.*, **93**, 1279–85 (*March* 15, 1954).

The energy spectra of photoneutrons from the absorption of 22 MeV bremsstrahlung by silver and bismuth have been measured with nuclear emulsions. Comparisons are made between the observed photoneutron spectra and those predicted on the basis of a statistical nuclear model. Energy level densities assumed proportional to $\exp[(a\varepsilon)^{\frac{1}{2}}]$ and $\ln(A\varepsilon/20 +$ where ε is the excitation energy of the residual nucl The exponential form of the energy level densit in better agreement with the data than is the logar mic form. However, for neutron energies gre than 4 MeV there are more photoneutrons obser than predicted by the exponential energy level den scheme. The angular distributions of photoneutr from several elements have been measured wit variety of neutron detectors. The moderated neut detector, which is equally sensitive to neutrons most energies, indicates the photoneutron flux to predominately isotropic. The small anisotropic co ponent has a maximum at 90 degrees to the X- beam. Photoneutrons from bismuth have a lar anisotropic component than photoneutrons from other element which was tested. In that case 21% the neutron flux is in the anisotropic compone The Al(n, p) reactions have been used to measure angular distributions of photoneutrons from seve elements. These reactions have thresholds 1·95 MeV and 2·69 MeV, respectively, and primarily sensitive to neutrons with more th 4 MeV energy. The angular distributions t observed have a maximum at 90 degrees to the Z- beam. In general, photoneutrons from the hea elements deviate more from isotropy than do light elements. An epithermal neutron detec indicates that the low-energy photoneutrons emitted isotropically. It is concluded that m photoneutrons are generated in a manner consist with the statistical nuclear model. The high-ener photoneutrons, which constitute a small fraction the total photoneutron flux, are ejected predominat at right angles to the X-ray beam as expected dipole absorption of the photons.

539.172

5965. The energy released in the disintegration nitrogen by thermal neutrons. R. Ishiwari an K. Yuasa. *Mem. Coll. Sci. Univ. Kyoto A*, 2 151–66 (*Oct.*, 1950).

The energy released in the $_7N^{14}(n, p)_6C^{14}$ reacti produced by thermal neutrons has been determin by the parallel plate ionization chamber with line amplifier filled with atmospheric air dried by CaC For the energy calibration, α-particles from Th were used as standard, and the correction for t systematic error introduced by the calibration w made by the aid of the theoretical analysis of th pulse shape in the linear amplifier. By assuming th proportionality between the amount of the tot ionization in air and the energy of the particle, th Q-value of the reaction was obtained as 0·609 0·005 MeV. Taking the end-point energy of th β-spectrum of $_6C^{14}$ as $0{\cdot}156 \pm 0{\cdot}001$ MeV, th neutron-hydrogen mass difference has been dete mined as $0{\cdot}765 \pm 0{\cdot}005$ MeV.

539.172

5966. (n, α) yields for pile neutrons in elements medium and high atomic number. I. $Zn^{68}(n, \alpha)Ni^{6}$ E. Sæland, M. Lykaas and K. Samsahl. *JENE Rep.*, *No.* 23, 10 *pp.* (1954).

No experimental data are available giving (n, α yields for fission neutrons in elements of medium an

atomic number, i.e. for (n, α) reactions of very "effective energy." As the first in a series of determinations the reaction $Zn^{68}(n, \alpha)Ni^{65}$ with pile neutrons has been examined. The average neutron cross-section $\bar{\sigma}$ was found to be 0·105% the cross-section for the reaction $P^{31}(n, p)Si^{31}$ which used as a reference. If one could use for the r the value of 0·019 barn, the result for the cross-on of the reaction $Zn^{68}(n, \alpha)Ni^{65}$ would be $2{\cdot}0\times10^{-5}$ barn. The "effective energy" of this tion with fission neutrons was calculated to be) MeV. A.

539.172.4

7. Total neutron cross section for uranium from eV to 20 MeV. R. L. Henkel, L. Cranberg, A. Jarvis, R. Nobles and J. E. Perry, Jr. *Phys.*, **94**, 141–3 (*April* 1, 1954).

The total neutron cross-section of normal uranium been measured for neutron energies from 20 keV 7·6 MeV and at 17, 19 and 20 MeV. When com-ed with other published work in the 7–14 MeV ge, the result is a smooth cross-section curve up to MeV. The curve fits smoothly on the surface wing total neutron cross-section as a function of h atomic weight and neutron energy. A.

539.172.4

58. Inelastic scattering of neutrons. E. A. Eliot, Hicks, L. E. Beghian and H. Halban. *Phys.*, **94**, 144–51 (*April* 1, 1954).

Experiments have been carried out on the inelastic ttering of 2·5 MeV neutrons by chromium, bis-uth, iron and indium, using scintillation counters. lastically scattered neutrons and γ-rays were served in a stilbene crystal and the results inter-ted by a ratio method. γ-Radiation alone was served in a sodium iodide crystal, using a normaliza-n technique to eliminate the neutron background. he following levels were identified: in chromium 42 ± 0·05 MeV (cross-section 1·0 ± 0·2 barns); in smuth 1·58 ± 0·05 MeV (0·6 ± 0·2 barns) and 85 ± 0·02 MeV (1·2 ± 0·3 barns); and in indium 92 ± 0·04 MeV (0·4 ± 0·1 barns) and 0·61 ± 06 MeV (0·2 ± 0·1 barns). Preliminary experi-ents with iron gave a level of 0·91 ± 0·15 MeV ·0 ± 0·3 barns). A.

539.172.4

69. Total cross sections for 410-MeV neutrons. . A. Nedzel. *Phys. Rev.*, **94**, 174–83 (*April* 1, 1954).

Good geometry transmission measurements were nducted in the high-energy neutron beam of the niversity of Chicago synchrocyclotron. Total cross-ctions of fourteen elements, measured at an effective eutron energy of 410 MeV, were determined as llows (units of millibarns): H, 33·7 ± 1·3; D, 2·0 ± 4; Be, 231 ± 4; C, 297 ± 3; O, 378 ± 5; l, 587 ± 8; S, 672 ± 9; Cl, 742 ± 10; Fe, 1073 ± 2; Cu, 1187 ± 14; Cd, 1848 ± 21; Pb, 2890 ± 30; h, 3210 ± 40; U, 3230 ± 40. It was found that he following two-parameter empirical formula was nsistent with the measured cross-sections to within he accuracy of their determination: $\sigma = 2\pi R^2[1 - \exp(-KR)]$, where $R = r_0A^{\frac{1}{3}}$, and the two constants ere chosen as $r_0 = 1{\cdot}20\times10^{-13}$ cm and $K = 360\times10^{13}$ cm^{-1}. The sole exception was hydrogen, r which the prediction by the formula was 5% below the measured value. The results are compared with neutron cross-sections at lower energies, with proton cross-sections at the same energy and are discussed from the point of view of the transparent optical model. A.

539.172.4 : 539.166

5970. Dipole and quadrupole transition probabilities in neutron-capture gamma radiation. B. B. Kinsey and G. A. Bartholomew. *Phys. Rev.*, **93**, 1260–78 (*March* 15, 1954).

An analysis of the intensities of neutron-capture γ-rays in even-charge nuclei shows that at high energies the emission probability of $E1$ radiation is greater than that of any other multipole order. This conclusion is supported by additional evidence from odd-charge nuclei. In three nuclei (Mg^{25}, Si^{29} and S^{33}) a direct comparison shows that (at the same energy) the emission probability of $E1$ is 200 times greater than that of $M1$ radiation. The rate of emission of $E2$ radiation has been compared directly with $E1$ radiation in only one instance, viz. Mg^{25}, where (at 7 MeV) it was found to be lower by a factor of 2000. Further evidence is adduced to show that this ratio is not exceptional and that the rate of emission of $E2$ radiation (at 7 MeV) is less than that of $M1$ radiation. The absolute rates of emission for $E1$ and $M1$ γ-rays are evaluated in those instances where the radiation width of the capturing state is known. When corrected for the level spacing near the initial state (and for the nuclear radius, in the case of $E1$ radiation), the rates of emission are remarkably constant; they are independent of the nuclear charge and mass over a range where the level spacing may vary by a factor of 10^4 or more. The emission rates of $E1$ and $M1$ radiation are generally ten times lower than those predicted by the formula of Weisskopf, which is based on the independent-particle model. The emission rates do not exceed those expected from that formula in the case of the exceptionally strong $M1$ ground-state γ-rays from F^{20} and Al^{28}. It is shown that the identification of the spins and parities of excited states in many nuclei can be made on the basis of intensity measurements, Finally, the influence of closed shells on the γ-ray spectra is discussed. A.

539.172.4

5971. Symposium on "Utilization of radiation from fission products" held at Harwell on 23rd and 24th February 1953. Edited by G. N. Walton and J. Wright. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. C/R* 1231, 161 *pp.* (1953).

This report includes 18 papers and discussion on the industrial use of fission products. Among the subjects covered are: properties of the products available; radiation for food preservation; sterilization of pharmaceutical products; medical uses; chemical, for polymerization; and effects of radiation on high polymers. There is a bibliography for the period 1945–53 (111 references).

539.172.4

5972. On the study of bi-partition and tri-partition of uranium nucleus. S. P. Dutta. *Indian J. Phys.*, **26**, 547–56 (*Nov.*, 1953).

Binary and ternary fissions of uranium under the action of slow neutrons were studied by photographic emulsion technique and it is intended to establish the

fact that in the case of tri-partition the third fragment may not necessarily be a light particle, of the nature of an α-particle, but can have a mass greater than 4. Accordingly, it was necessary to desensitize the experimental nuclear plates by increasing the concentration of $UO_2(NO_3)_2,6H_2O$ in alcohol in which they were bathed. A concentration of 12 to 16% was found most favourable due to various factors. More than 20 000 cases of bi-partition and one interesting case of tri-partition were observed. The calculated mass values were 166, 43 and 30; but from the nature of ionization, the mass value of the third fragment is expected to lie between 15 to 20 instead of 30. The calculated kinetic energy of this tri-partition is 2×10^9 eV instead of $1{\cdot}5\times10^8$ eV and hence it is assumed that the fission has been initiated by a high energy fast neutron (of cosmic-ray origin) the direction and value of which only can help to determine the correct mass values. In such highly desensitized plate the total-range distribution of the two fission fragments is shown by a histogram and most of them lie between 20 and 21 μ. The corresponding value in a non-desensitized plate is 24 μ approximately. A.

539.172.4

5973. $_{94}Pu^{240}$ and its spontaneous fission. O. Chamberlain, G. W. Farwell and E. Segrè. *Phys. Rev.*, **94**, 156 (*April* 1, 1954).

Measurements of spontaneous fission of $_{94}Pu^{239}$ show that neutron irradiation of this substance forms a body with a high spontaneous-fission rate. This substance is with practical certainty $_{94}Pu^{240}$ and has a spontaneous-fission rate of approximately $1{\cdot}6\times10^6$ fissions/g hr. $_{94}Pu^{239}$ itself has a spontaneous-fission rate of the order of 40 fissions/g hr. A.

539.172.4

5974. Energy spectrum of spontaneous fission fragments. E. Segrè and C. Weigand. *Phys. Rev.*, **94**, 157–8 (*April* 1, 1954).

The energy spectrum of spontaneous fission fragments of Pu^{240} is compared with the same spectrum for slow-neutron fission of Pu^{239}. No significant difference was found, and the interpretation of this result is discussed. A.

539.172.4

5975. Spontaneous fission systematics. J. R. Huizenga. *Phys. Rev.*, **94**, 158–60 (*April* 1, 1954).

Previous correlations of spontaneous fission half-lives *v.* Z^2/A predict that the half-lives of even-even isotopes increase with A. A deviation from the above correlation is discussed, and it is shown that the spontaneous fission half-lives of the even-even isotopes go through a maximum with increasing A. The shorter spontaneous fission half-lives beyond the maximum may be a result of the greater deformations of the larger-A nuclides. Some comments are made on fission thresholds. A.

539.172.4

5976. Pile neutron research. D. J. Hughes. *Cambridge, Massachusetts: Addison–Wesley Publishing Co.* (1953) xiii + 386 *pp.*

Review in *Nature* [*London*] **173**, 462–3 (*March* 13, 1954).

539

5977. Degradation of fast neutron spectrum light reflector. J. P. Elliott. *Atomic Energy Establ.* [*Harwell*] *Rep. T/R* 1244, 13 *pp.* (1953).

Using a simple spherical model consisting core, a reflector of light material and a ura blanket, a method is given to determine the ve distribution of neutrons in the core. It is ass that all cross-sections are independent of energy slowing down takes place only in the reflecto that fission takes place only in the core. Calcula are made for beryllium reflectors of thickness and 6 cm, and for aluminium reflectors of thic 3 cm and 30 cm. The energy released in the ref by slowing down of neutrons is also calculated.

539.

5978. Shielding studies. II. The distributio γ-radiation in graphite-moderated uranium rea C. C. Horton. *Atomic Energy Res. Establ.* [*Ha Rep. R/R* 1271, 6 *pp.* (1953).

The distribution of γ-radiation in the core, refl thermal column, and a mock thermal shield of li was studied using a "homogeneous" ion cha The chamber is of simple construction and its o current is a known function of the γ-energy depo in the chamber volume. The results may be fitt formulae based on a simple method of calculati γ-ray transmission through matter. It is shown the radiation escaping from a typical gra uranium reactor consists mainly of γ-rays neutron capture in the moderator and the shield, these have an effective energy of about 5 The γ-radiation in the core of such a reactor is s to consist mainly of soft γ-rays originating in fission process and from decay of the fission prod Using these results the distribution of γ-rays i shield of BEPO has been calculated, and show fit data obtained by other experiments over the of measurement.

539.

5979. Plans for the new Argonne research re CP-5. S. Untermyer. *Nucleonics*, **12**, 12–15 1954).

The reactor employs a core of enriched U heavy water moderator and coolant. The $1{\cdot}1$ kg of U^{235}, is in the form of Al–U alloy wiched between thin sheets of Al to form 3 in. $\times$ 24 in. $\times$ 0·06 in. These are formed int assemblies of 10 parallel plates of 3 in. $\times$ 3 in. section; each assembly containing about 75 U^{235}. The assemblies are arranged in a lattice i central part of the D_2O tank. The reflector co of about 60 cm thickness of D_2O around the and a 40 cm layer of graphite around the tank. operating power is 1 MW giving a maximum the neutron flux of 3×10^{13} in the centre of the cor very high degree of thermalization is obtained a outside of the D_2O tank. Various experim facilities are provided. L. R. Shep

539.

5980. Kinetic behavior of a thermal heavy-w reactor. A. Lundby and N. Holt. *Nucleonics* 22–5 (*Jan.*, 1954).

Experiments, in which sudden increases in activity were applied to the JEEP reactor by eje

d rabbit from the centre of the reactor, are ribed. The counting rate in a fast scintillation ctor (a *p*-terphenyl solution monitoring prompt ys from neutron capture in Cd) was used to erve the rise in the reactor power level. The tics of the reactor are discussed and comparisons le between the theory and results. From the nsient behaviour of the reactor power level, during first second after ejection of the Cd, it was deduced t the prompt neutron lifetime in the JEEP is 10^{-3} sec. L. R. SHEPHERD

539.172.4

1. Discontinuous servo for control of power ctors. J. M. HARRER AND J. A. DESHONG, JR. *cleonics*, **12**, 44–51 (*Jan.*, 1954).

n the device under discussion, a control rod is ven in a corrective direction at a fixed δk/sec, enever the power level of the reactor drifts above below a prescribed range. The driving motor is pped when the power level comes within this ge. An analysis of the characteristics and stability the system is given. The design and performance of e control system of the CP-3′ reactor at the Argonne ational Laboratory are described. L. R. SHEPHERD

539.172.4

82. Reactor power calibration. M. A. SCHULTZ D J. C. CONNOR. *Nucleonics*, **12**, 8–12 (*Feb.*, 1954). Methods of calibrating neutron detectors in terms absolute reactor power-output are discussed. It is own that various factors, such as neutron distri- tion variation and γ-radiation, can seriously affect e calibration. The authors conclude that neutron tectors can give only a rough indication of power vel and are more suitable for safety and alarm rposes. L. R. SHEPHERD

539.172.4

983. Concept of stability for nuclear reactors. . B. ROBINSON. *J. appl. Phys.*, **25**, 516–18 (*April*, 954).

Equations relating neutron density, temperature nd excess multiplication of a nuclear reactor are ansformed so as to be suitable for phase plane presentation. The concepts of orbital, secular and symptotic stability are examined. The significance f each type of stability for reactor operation is iscussed. Orbital stability is relevant for reactors hose stable states involve an oscillation of tempera- ure (and neutron density); the other two types involve eactors whose stable states are constant temperatures nd neutron density. The latter two types may also e required (for some special considerations) of a eactor possessing orbital stability. A.

539.172.4 : 591.088.5

Neutron and inherent gamma flux measurement in hermal column of Los Alamos "Water Boiler." *See lbstr.* 6193

ATOM AND MOLECULE BEAMS. MESONS . NEUTRONS 539.18

539.18

984. "*V* dinucleons." H. PRIMAKOFF AND W. HESTON. Letter in *Phys. Rev.*, **93**, 908 (*Feb.* 15, 1954). Various systems of *V*-particle plus nucleon forming semi-stable structures are considered. Possible decay schemes of such systems are given. G. E. BROWN

539.18 : 537.531

5985. Relative intensities of π and μ meson X-rays of the *K* and *L* series in low *Z* elements. M. B. STEARNS, S. DEBENEDETTI, M. STEARNS AND L. LEIPUNER. Letter in *Phys. Rev.*, **93**, 1123 (*March* 1, 1953).

The X-rays following the stopping of a 110 MeV π^- in a C, N, O, F, Na, Mg, Al, P, S, Cl or K target (placed in an anticoincidence stilbene telescope) are analysed by a 24-channel selector of NaI pulses. Decrease of intensity with Z can be understood as due to nuclear capture. W. J. SWIATECKI

539.18

5986. On the possible ejection of a meson-active triton from a nuclear disintegration. A. BONETTI, R. L. SETTI, M. PANETTI, L. SCARSI AND G. TOMASINI. Letter in *Nuovo Cimento*, **11**, 210–12 (*Feb.*, 1954).

Describes an event observed in stripped emulsion exposed at balloon altitudes. An unstable heavy particle was emitted from a star and came to rest after travelling a total distance of ~13 mm. Two tracks originate from the end of the primary track. The first of these is 9·6 μ long and heavily ionizing, the other in the opposite direction, has an ionization ~1·7 minimum, and after a distance of 2·38 cm ends in a five-prong star. The event is discussed in detail and it is concluded that it probably represents the decay of an excited triton according to the scheme $H_1^{3*} \rightarrow He_2^3 + \pi^- + (41{\cdot}7 \pm 1)$ MeV. H. ELLIOT

539.18

5987. Remarks on the decay of a meson-active triton [i.e. neutron replaced by Λ°]. A. BONETTI, R. L. SETTI, M. PANETTI, L. SCARSI AND G. TOMASINI. Letter in *Nuovo Cimento*, **11**, 330–1 (*March*, 1954).

The energy release of $41{\cdot}7 \pm 1$ MeV in $H_1^{3*} \rightarrow He_2^3 + \pi^-$ when combined with the Q-value of $37{\cdot}3 \pm 0{\cdot}5$ MeV for the free Λ° (see abstract following), leads to a value of ~1 MeV for the binding energy of the Λ° in the triton. W. J. SWIATECKI

539.18

5988. Excited nucleons. C. F. POWELL. *Nature* [*London*] **173**, 469–71 (*March* 13, 1954).

Recent experiments with stacked emulsions [Abstr. 4992 (1954)] give the mass of the Λ° particle as $2182 \pm 2\, m_e$ and the energy release in $\Lambda^\circ \rightarrow p + \pi^-$ as $37{\cdot}2 \pm 0{\cdot}5$ MeV. Using this in an analysis of the recently observed events in which light nuclei disintegrate with the emission of a π^-, one can exclude the interpretation in terms of a meson in an orbit round one of the nucleons in favour of an internal excitation of a *P*. W. J. SWIATECKI

539.18

5989. Total cross sections of 135-MeV to 250-MeV negative pions in hydrogen. J. ASHKIN, J. P. BLASER, F. FEINER, J. GORMAN AND M. O. STERN. Letter in *Phys. Rev.*, **93**, 1129 (*March* 1, 1954).

Nine transmission measurements (accurate to 2–4%) confirm a maximum in the total cross-section at 180 MeV [see Abstr. 4632 (1952)]. W. J. SWIATECKI

539.18

5990. Decay-electron spectrum of the μ-meson. J. H. VILAIN AND R. W. WILLIAMS. Letter in *Phys. Rev.*, **92**, 1586–7 (*Dec.* 15, 1953).

Photoproduced π^+'s and e^+'s from the subsequent π–μ–e decay were photographed in a cloud chamber in a field of 9000 gauss. The accepted 280 e^+'s follow L. Michel's spectrum [Abstr. 5516 (1950)] with the end point not going to zero ($\rho = 0{\cdot}50 \pm 0{\cdot}12$).

W. J. SWIATECKI

539.18 : 539.165

5991. μ-Meson decay, β radioactivity, and universal Fermi interaction. L. MICHEL AND A. WIGHTMAN. Letter in *Phys. Rev.*, **93**, 354 (*Jan.* 15, 1954).

Employing the new experimental value of the μ-meson mass $m = 207{\cdot}0 \pm 1{\cdot}0\, m_e$ these authors analyse possible universal interactions. They find that most of the usual interactions are incompatible with the experimental data, but obtain a good fit with a general interaction of a type $^{\pm}S + T + pP$.

G. E. BROWN

539.18

5992. On a possible negative $K \to \pi$-meson decay. E. AMALDI, G. BARONI, C. CASTAGNOLI, G. CORTINI, C. FRANZINETTI AND A. MANFREDINI. Letter in *Nuovo Cimento*, **11**, 207–9 (*Feb.*, 1954).

Two *K*-meson tracks have been identified amongst the secondaries emerging from a star. One of these has a total range of 18 mm and shows a scattering or decay 3 mm before escape from the last emulsion. Preliminary estimates give a value of $\sim 1000\, m_e$ for the mass. The other has a total range of 12·1 mm and at the end of its range it decays into a negative π-meson with a range of 23·2 mm and which gives rise to a three prong star. The mass of this *K*-meson, determined from grain density measurements, is $1060 \pm 50\, m_e$. Various alternative interpretations are discussed.

H. ELLIOT

539.18 : 537.591.8

A *V*-decay event with a heavy negative secondary. *See Abstr.* 5783

539.18

5993. A double star connected in a heavy meson. S. ROSENDORFF, R. STAHL AND G. YEKUTIELI. Letter in *Phys. Rev.*, **93**, 901 (*Feb.* 15, 1954).

The heavy meson is emitted from a star produced by an α-particle of 5 BeV energy. The mass of the meson is estimated to be $1300 \pm 125\, M_e$ and after travelling a distance 34 mm in the emulsion it produces a secondary star. Taking this event together with the total observed path-length of identified *K*-particles it is concluded that the interaction mean free path is the same for *K*-particles and pions.

H. ELLIOT

539.18

5994. An improved method for determining the mass of particles from scattering *versus* range and its application to the mass of *K*-mesons. S. BISWAS, E. C. GEORGE AND B. PETERS. *Proc. Indian Acad. Sci. A*, **38**, 418–39 (*Nov.*, 1953).

A new method is developed for determining the mass of particles coming to rest in nuclear emulsions. Multiple Coulomb scattering is measured with cells whose lengths vary along the trajectory in such a manner as to compensate for the momentum lo the particle and keep the mean deviation bet adjacent cells constant over the entire track. shown that this procedure is more convenient inherently more accurate than that based on scatt measurements with constant cellsize. The me has been applied to *K*-mesons which at the end of range either decay into a single charged relativ particle (K^+-mesons) or into 3π-mesons (τ-mes or give rise to capture stars (K^--mesons). The re are within experimental error consistent with assumption that the mass of these three classe particles are identical and equal to the well establi mass of the τ-mesons. The average mass of a gr of 9 long *K*-mesons determined in this manne $M_K = 974 \pm 52\, m_e$.

53

5995. Rest mass energy of the negative pion. R. CORNELIUS, C. P. SARGENT, M. C. RINEHART, L. LEDERMAN AND K. ROGERS. Letter in *Phys. R* **92**, 1583 (*Dec.* 15, 1953).

The analysis of a $\pi^- + p \to n + e^- + e^+$ ev photographed in a diffusion cloud chamber lead $m(\pi^-) = 268{\cdot}8 \pm 1{\cdot}8\, m_e$. W. J. SWIATE

539.18 : 778

Study of *K*-mesons and hyperons with large nucl emulsion detectors. *See Abstr.* 6216

539

5996. Observations on τ-mesons and on *K*-mes giving rise to capture stars. D. LAL, Y. PAL AND PETERS. *Proc. Indian Acad. Sci. A*, **38**, 398–417 (*N* 1953).

In an emulsion block detector [Abstr. 6216 (195 exposed in the stratosphere three cases of the p duction of τ-mesons in nuclear disintegrations ha been observed and 5 cases of negative *K*-mesons wh when brought to rest are captured by nuclei. In c case the production of a τ-meson is associated w the production of a charged hyperon in the sa nuclear event. In another case the production o negative *K*-meson is associated with the producti of a slow positive *K*-meson. The production ratio slow τ-mesons to slow positive π-mesons τ/π^+ $1{\cdot}1^+ 0{\cdot}8\%$ and the ratio of slow negative *K*-mesons slow negative π-mesons, $K^-/\pi^- = 0{\cdot}95 \pm 0{\cdot}5\%$. T mass of the τ-meson is found to be $M\tau = 975{\cdot}9$ $2{\cdot}2\, m_e$, and that of K^--mesons $M_{\bar{K}} = 927 \pm 75\, m$ Proof is given that all three of the decay products the τ-mesons are π-mesons. It is suggested that a τ-mesons observed to decay in emulsions are pos tively charged and that the K^--mesons observed ma be the negative counterpart of this particle. Possib relations between the various phenomenologically di tinguished types of charged *K*-mesons are discusse

539.1

5997. Kinematic criterion for meson production fundamental particle collisions. R. M. STERNHEIME Letter in *Phys. Rev.*, **93**, 642 (*Feb.* 1, 1954).

The maximum angle of the recoil proton in neutron proton and pion–proton collisions is calculate assuming production of various numbers of pions the collisions.

G. E. BROW

539.18

8. Photoproduction of π^+ mesons from hydrogen l carbon. G. S. JANES AND W. L. KRAUSHAAR. tter in *Phys. Rev.*, **93**, 900 (*Feb.* 15, 1954).

Yields and energy distributions of 10 MeV to 5 MeV π^+-mesons have been measured at 90° boratory angle. J. J. WILKINS

539.18

99. Artificially produced negative heavy meson. HORNBOSTEL AND E. O. SALANT. Letter in *Phys. v.*, **93**, 902 (*Feb.* 15, 1954).

One such meson of $m = 1050 \pm 150\, m_e$ was found stacked emulsions placed to intercept 310–380 MeV gative particles leaving a Be target exposed to 2 BeV protons. The lifetime is estimated as $> 0{\cdot}9 \times 10^{-9}$ sec. W. J. SWIATECKI

539.18

00. Some possible relationships between π-meson cleon scattering and π-meson production in nucleon-cleon collisions. A. AITKEN, H. MAHMOUD, E. M. ENLEY, M. A. RUDERMAN AND K. M. WATSON. *hys. Rev.*, **93**, 1349–55 (*March* 15, 1954).

For a reaction such as $p + p \rightarrow \pi^+ + n + p$, it is nown that the interaction of the emitted neutron and roton will frequently result in the formation of a euteron. An analogous effect is that of the inter-ction of the π meson with either the neutron or the roton. This interaction is known to be strong from udies of meson–nucleon scattering. Explicit calcu-tions are made, which indicate that pronounced ualitative effects may indeed result from the meson–ucleon interaction. In particular, the $p + p \rightarrow \pi^+$ ross-section is expected to be considerably larger han is the $n + p \rightarrow \pi^+$ cross-section. A.

539.18

001. The production of charged pions at 180° to he beam by 340-MeV protons on carbon. S. L. EONARD. *Phys. Rev.*, **93**, 1380–6 (*March* 15, 1954).

The yield of charged pions at 180° ± 5° to the beam roduced by 340 MeV protons on carbon has been neasured, using nuclear emulsion techniques. Nuclear emulsions embedded in copper, aluminium, or Lucite absorber blocks were exposed to magnetic-lly separated positive and negative pions emitted at 180° by graphite targets bombarded in the electrically deflected proton beam of the Berkeley synchro-cyclotron. Plates were exposed for a series of pion energies from 9 to 118 MeV. The developed emul-sions were examined with a microscope under high magnification and meson track endings were identified and counted. The values of $d\sigma/d\Omega dT$ as a function of pion energy and the values of $d\sigma/d\Omega$ were calcu-lated for both positive and negative pions. Correc-tions were made for errors resulting from pion decay in flight, the finite thickness of the target, nuclear interaction of pions in the target and absorber blocks, and background pions. The corrected integrated cross-sections are $d\sigma/d\Omega(\pi^+) = 1{\cdot}77 \pm 0{\cdot}27 \times 10^{-28}$ cm^2/(sterad nucleus) and $d\sigma/d\Omega(\pi^-) = 1{\cdot}90 \pm 0{\cdot}38 \times 10^{-29}$ cm^2/(sterad nucleus), yielding a positive–negative ratio of $9{\cdot}3 \pm 2{\cdot}3$. An attempt has been made to interpret the positive pion spectrum in terms of ex-isting information on the production of positive pions by protons on hydrogen. A.

539.18

6002. Pion production by polarized beams of nucleons. R. E. MARSHAK AND A. M. L. MESSIAH. *Nuovo Cimento*, **11**, 337–41 (*April*, 1954).

Pion production by polarized beams of high energy nucleons is now possible. It is advantageous to look for an azimuthal asymmetry in the angular distribution of the produced pions. As an illustration, the expected asymmetry of the π^+ mesons produced in the reaction $p + p \rightarrow \pi^+ + d$ is calculated assuming that the pion–nucleon interaction possesses both s and p-wave components. It is shown that a study of this reaction using polarized beams of protons may decide whether both the s and p interactions contribute to pion production by nucleons (say, at energies below 500 MeV). A.

539.18

6003. On the elastic scattering of positively and negatively charged μ-mesons by heavy nuclei. H. MARSCHALL. Note in *Naturwissenschaften*, **41**, *No.* 3, 56–7 (1954).

Using the WKB approximation in a phase-shift analysis, the angular distributions were calculated ($\theta = 30$ to 150°) for 25 and 50 MeV $\mu^\pm$ on Pb^{208}. Considerable deviations from point-charge scattering result. W. J. SWIATECKI

539.18

6004. The anomalous large angle scattering of μ-mesons. J. P. DAVIDSON. *Nuovo Cimento*, **11**, 205–6 (*Feb.*, 1954).

The electromagnetic field of the meson is decomposed into an equivalent beam of incident photons by the Weizsäcker–Williams method. These photons can excite the nuclei; a resonance for absorption occurs in the neighbourhood of 15–20 MeV [Abstr. 7930 (1953)] for all nuclei. This results in a cross-section for incoherent scattering $\sim 3{\cdot}34 \times 10^{-29}$ cm^2/nucleon for 300 MeV μ-mesons scattered by lead. G. E. BROWN

539.18

6005. Scattering of 65-MeV pions in hydrogen. D. BODANSKY, A. M. SACHS AND J. STEINBERGER. *Phys. Rev.*, **93**, 1367–77 (*March* 15, 1954).

A measurement has been made at approximately 65 MeV of the differential cross-sections in the processes $\pi^+ + p \rightarrow \pi^+ + p$, $\pi^- + p \rightarrow \pi^- + p$ and $\pi^- + p \rightarrow \pi^0 + n$, using a liquid hydrogen target and scintillation counter detectors. Because of Coulomb interference effects, the experiment affords the opportunity of determining the signs as well as the magnitudes of the phase shifts in an analysis including only s and p waves. It is found that two very markedly different sets of phase shifts fit the data. Each of these sets includes subsets of the Fermi and Yang type. The results of this experiment, in conjunction with those of similar experiments, favour a set characterized by a strong attractive p wave interaction in the $T = \frac{3}{2}$ isotopic spin state. A.

539.18

6006. The *S*-wave in pion-nucleon scattering. M. M. LÉVY AND R. E. MARSHAK. *Nuovo Cimento*, **11**, 366–71 (*April*, 1954).

A calculation is made of the two S-phase shifts of pion–nucleon scattering corresponding to isotopic

spin states $T = 1/2$ and $T = 3/2$, using the Tamm–Dancoff method and an extended source model for the nucleon. The magnitude and energy variation of the α_3 phase-shift agree reasonably well with experiment. The sign of the α_1 phase-shift is correct, but its magnitude is completely wrong. It is likely, however, that α_1 is the S-phase shift which will be seriously altered by taking account of renormalization effects in a more rigorous treatment of the problem. A.

539.18

6007. On the spin of the μ-meson. K. Iwata. *Progr. theor. Phys.*, **10**, 451–6 (*Oct.*, 1953).

The possibility of determining the spin of the μ-meson is shown in the study of anomalous π–μ decay. This possibility is due to the fact that the ratio $R(= W_r/W_0)$ of the probability of the radiative process $W_r(\pi \to \mu + \mu_0 + \gamma)$ to that of the ordinary one $W_0(\pi \to \mu + \mu_0)$ for a meson of spin 1/2 differs from that for the meson of spin 0. The range of the μ-meson track shorter than 150 μ is particularly interesting, because, for such a short μ-track, the contribution from the magnetic dipole of the μ-meson is more effective than the electric current contribution. The above-mentioned R (range $< 150\ \mu$) is $1/4 \times 10^{-4}$ for a muon of spin 1/2 and $1/13 \times 10^{-4}$ for a spin 0 muon. It is shown that the straggling effect does not disturb the determination of the spin. The ratio has been measured by Fry *et al.* Out of 10 686 events in the photographic plate, it was found that there was only one μ-track of range shorter than 150 μ. It is desirable to increase the accuracy and the statistical weight of the observation in order that a more precise comparison between theory and experiment may be possible. A.

539.18 : 530.145

On the neutrino charge of elementary particles. *See Abstr.* 5290

539.185

6008. Time dependence of boron absorption coefficient for neutrons slowed down in water at room temperature. G. von Dardel. *Ark. Fys.*, **7**, *Paper* 28, 357–73 (1953).

Bursts of fast neutrons were fired into a water moderator, and the boron absorption coefficients for the neutrons leaving at various later times were measured. After the initial moderation period, the "temperature" of the slow neutrons approaches the temperature of the moderator roughly exponentially, with a time constant of about 7 μsec. J. M. Cassels

539.185

6009. The thermal neutron transport parameters in water. J. P. Elliott. *Atomic Energy Res. Establ.* [*Harwell*] *Mem. T/M*91, 10 + iii *pp.* (1953).

An attempt is made to establish consistency between the cross-section data and the transport parameters for thermal neutrons in water. The mean cosine of scattering angle is calculated for a bound proton to deduce $l_{tr}(v)$ from the known $l_{sc}(v)$. The correct manner of averaging over the Maxwell energy distribution is discussed. The appropriate average values of l_{tr} and L do not agree with the experimental data although this data is still uncertain. Interference between the scattered waves from the two protons is the most likely cause of this difference. It se probable that agreement will be obtained when effect is taken into account and a reliable experim is made to determine L and l_{tr}.

539.

6010. Diffusion length of thermal neutrons in wa J. A. DeJuren and H. Rosenwasser. *J. Res. Bur. Stand.*, **51**, 203–7 (*Oct.*, 1953).

The thermal-neutron diffusion length in a hyd genous medium can be simply determined measuring the variation of the thermal-neutr density at large radii from the centre of a phd neutron source. The necessary requirement is t the relaxation length of the source in a mediumi less than the diffusion length, so that diffus dominates at large radii. Using a Ra–Be phd neutron source, the diffusion length of ther neutrons was determined by indium-foil measureme at large radii. A value of $2{\cdot}763 \pm 0{\cdot}015$ cm obtained. This result was confirmed in a secc experiment with an Sb^{124}–Be source.

539.

6011. Multigroup methods for neutron diffus problems. R. Ehrlich and H. Hurwitz, *Nucleonics*, **12**, 23–30 (*Feb.*, 1954).

The range of energies of neutrons in a reactor divided into a number of discrete intervals and t age-diffusion equation is thereby reduced into set of coupled differential equations (multigro equations). Analytical and numerical methods f solving these equations are discussed. The adjoi equation is also expressed in multigroup form a the use of the adjoint function to calculate values the reactivity, is described. A sample calculation a spherical intermediate system with 30 cm co radius and 20 cm reflector thickness is given.

L. R. Shepher

539.1

6012. Energy spectrum of neutrons from Po–B J. O. Elliot, W. I. McGarry and W. R. Faus *Phys. Rev.*, **93**, 1348–9 (*March* 15, 1954).

The energy spectrum of neutrons from a Po–B source has been observed by means of a coincidenc scintillation spectrometer.

539.18

6013. On the electrostic neutron-electron interaction J. Olszewski. *Acta phys. Polon.*, **12**, *No.* 2, 135–4 (1953).

The neutron-electron static interaction is invest gated by means of the Dyson technique with the us of formalistic regularization. It is shown that beside the convection current also the polarization curren yields a non-vanishing contribution to the stati interaction, the latter contribution being about thre times as large as the former. A

539.18

6014. Incoherent neutron scattering by polycrystals G. Placzek. Letter in *Phys. Rev.*, **93**, 895 (*Feb.* 15 1954).

If the incoherent scattering cross-section is expanded in powers of the ratio of neutron to nuclear mas m^{-1}, the expansion is found to converge rapidly fo

energies, provided M is moderately large compared to one and T/θ (θ is the Debye temp.). The coefficients in the expansion are evaluated for the particular case of low energy and high temperature.

J. HUGHES

539.185.08

6015. A critical comparison between some methods for measuring the strength of a Ra–Be neutron source absolutely. K.-E. LARSSON. *Ark. Fys.*, **7**, *Paper* 25, 223–42 (1953).

The neutron yield of a 250 mg Ra–α–Be source has been determined using two different methods, firstly by integrating the neutron density in a boric acid solution with a small BF_3–chamber and secondly by integration of the neutron density in pure water, using gold foils and subsequent absolute counting of the induced activity. The values found for the yield are $(2{\cdot}57 \pm 0{\cdot}12)\times10^6$ neutrons/sec with the BF_3 chamber method, and $(2{\cdot}62 \pm 0{\cdot}08)\times10^6$ neutrons/sec with the gold foil method. The neutron yield of this source has also been directly compared with the yield of a Harwell standard source, the result of the comparison being $(2{\cdot}64 \pm 0{\cdot}13)\times10^6$ neutrons/sec, and indirectly with a Los Alamos source, giving the result $(2{\cdot}55 \pm 0{\cdot}21)\times10^6$ neutrons/sec. A.

539.185.08

6016. Fast neutron dosimetry. G. S. HURST AND R. H. RITCHIE. *Radiology*, **60**, 864–9 (*June*, 1953).

Two methods are described for measuring the tissue dose due to fast neutrons in the presence of γ-radiation. The first dosimeter is a proportional counter designed so that the variation of counting rate with neutron energy is the same as the variation of tissue dose with energy. The counting rate is therefore a measure of the tissue dose rate due to neutrons. The instrument is rather directional. The second instrument is a proportional counter in which the total ionization is a measure of tissue dose. In order to produce an instrument insensitive to γ-radiation the number of ion pairs is determined by adding pulse heights. A suitable bias then cuts out the smaller γ-pulses. A simple circuit for pulse integration is described. H. MILLER

539.185.08

6017. Absolute calibration of the NBS standard thermal neutron density. J. A. DE JUREN AND H. ROSENWASSER. *J. Res. Nat. Bur. Stand.*, **52**, 93–6 (*Feb.*, 1954).

A moderating geometry providing a constant thermal neutron flux from two radium-beryllium (α, n) sources has been constructed. The flux at the centre of the geometry has been calibrated by absolute α-counting from boron films exposed in pulse ionization chambers. The boron capture cross-section has been obtained by comparison of the N.B.S. boron with the Argonne "standard" boron, and a value of $n\bar{v} = 3918$ ($\pm 2\%$) n/cm^2. sec has been determined for the flux. A.

539.185.08 : 537.542

6018. A high-sensitivity fast neutron survey meter. J. S. HANDLOSER AND W. A. HIGINBOTHAM. Note in *Rev. sci. Instrum.*, **25**, 98 (*Jan.*, 1954).

A portable instrument using a dispersion of activated ZnS in Lucite and a 5819 photomultiplier is described. Extra-high tension is provided by a Ne-tube oscillator and the whole instrument works from 135 V batteries. Sensitivity is 70 counts per min for a neutron flux of 20 n/cm^2 per sec. F. T. FARMER

539.185.7

6019. On a statistical photographic method of determining the cross-sections for the absorption of slow neutrons. M. WIELOWIEJSKA. *Acta phys. Polon.*, **12**, *No.* 1, 8–13 (1953).

A statistical photographic method of measuring the cross-sections for the absorption of thermal neutrons (0·025 eV) in aluminium and lead has been elaborated. The flux of photoneutrons from the reaction $Be^9(\gamma, n)2\alpha$ slowed down in paraffin wax was determined by evaluating the density of the $_1H^3$ and $_2He^4$ tracks in the emulsions of 100 μ Ilford C2 nuclear research plates loaded with lithium. This method was applied to the determination of the cross-section of Al and Pb atoms for the total absorption of thermal neutrons. The results are in good agreement with those obtained by other methods. A.

539.185.7

6020. Some approximate formulae for use in neutron shielding. K. T. SPINNEY. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. T/R* 1221, 13 + ii *pp.* (1953).

The general subject of neutron shielding is discussed with special reference to a recent analytic theory due to Holte [Abstr. 6479 (1951)]. Approximate formulae are given for the neutron collision density, as a function of energy and distance, due to a point source in an infinite moderating medium. A.

539.185.7

6021. The *n* unit and energy absorption in tissue. H. H. ROSSI. *Radiology*, **61**, 93–6 (*July*, 1953).

Tests have been made of the response of a number of Victoreen chambers to X-rays and neutrons. The average response of the 25r chambers was 1·95 rep/*n* but the chamber response to neutrons varied by about 15% even when variations of X-ray response were allowed for by appropriate calibration. H. MILLER

539.185.9

6022. Radiation damage in SiO_2 structures. M. WITTELS AND F. A. SHERRILL. Letter in *Phys. Rev.*, **93**, 1117 (*March* 1, 1954).

The effects of neutron irradiation on cristobalite, tridymite, glass and in particular quartz crystals. The marked relationship between the density and structural changes of quartz is discussed. Heavy doses of fast neutrons reduce all four solids to a common isotropic glass. A. D. LE CLAIRE

STRUCTURE OF SOLIDS 539.2

539.213

6023. Coexisting structures in vitreous silica. C. L. BABCOCK, S. W. BARBER AND K. FAJANS. *Industr. engng Chem.*, **46**, 161–6 (*Jan.*, 1954).

The unusual behaviour of vitreous silica indicates that its structure may involve two or more distinctly

different atomic arrangements coexisting in a homogeneous equilibrium in ratios that vary with temperature and pressure. The very small expansion coefficient can be explained if, under given conditions, the "structures" dominant at low temperatures have a larger volume than the others. The exceptional behaviour of both, the compressibility and the elastic properties of the glass, are consistent with this assumption. Low-temperature heat capacity, as well as infrared and Raman spectra, indicate the coexistence of relatively weak and strong forces, or of large and small vibrating masses, or both. The fact that the unusual behaviour of vitreous silica is observable during measurements at moderate temperatures shows that the assumed mutual conversions of the coexisting structures are rapid and reversible. Besides these structures, one has to distinguish various relatively stable "states" which the glass assumes depending on thermal history. A.

539.213 : 530.162

6024. Statistical theories as applied to the glassy state. O. L. Anderson and D. A. Stuart. *Industr. engng Chem.*, **46**, 154–60 (*Jan.*, 1954).

Application of statistical mechanics to non-equilibrium phenomena in inorganic glasses is reviewed, including ionic conductivity, diffusion, internal friction, viscosity and fracture. Emphasis is placed on the connection between the physical assumptions of the various theories and the structure of glass. The theories discussed all involve several arbitrary parameters which are usually determined by requiring that the theoretical curves "fit" experimental points. Although in some cases the different theories explaining the same phenomena appear very different, many theories can be correlated with one another and many points of similarity found. In some cases the different results obtained by individual investigators are due to differences in terminology rather than method. The correlation of various theories is suggested as a means of reducing the number of arbitrary parameters in the theories. A.

539.213 : 539.27

6025. Electron microscope investigation of glass. A. F. Prebus and J. W. Michener. *Industr. engng Chem.*, **46**, 147–53 (*Jan.*, 1954).

Evidence of structural inhomogeneities in glass up to several hundred angstroms in maximum dimension has been obtained, using the electron microscope. Direct transmittance electron micrographs show the structure with a high degree of contrast. There is a wide variation in structure among the various glasses investigated. The structural evidence is interpreted as indicating the possibility of a relatively high degree of order over distances ranging from 20 Å up to at least 200 Å. A.

539.215.2 : 539.26

6026. Measurement of the granularity of a crystalline powder by X-ray diffraction. R. Bernard and R. Rivière. *C.R. Acad. Sci.* [*Paris*] **238**, 666–9 (*Feb.* 8, 1954) *In French.*

Measurements of X-ray line profile were made on tungsten carbide after grinding for periods up to 430 hours. These suggest that there are two modes of production of small particles, one producing mu smaller particles than the other. A. R. STO

539.21

6027. Subsieve particle-size measurement of me powders by air elutriation. R. E. Pollard. *J. R Nat. Bur. Stand.*, **51**, 17–31 (*July*, 1953).

Particle-size measurements of spherical me powders by means of the Roller air analyser, usi samples up to 40 g of powder, were found to reproducible within approximately ±1% of t original weight of the sample for particle diamet up to 120 μ. The separation limits closely appro mated those required by Stokes law ($V = K$ for particle diameters of 5 to 20 μ. For parti diameters of 20 to 70 μ, the size limits of fra tions conformed approximately to the formu $V = K''d^{1\cdot4}$. With particles larger than 70 μ, t accuracy of separation was uncertain. Reproducib results also were obtained with irregularly shap particles, such as those of electrolytic copper powd However, the accuracy of calculated size limits w uncertain, no attempt being made to check them other methods of measurement.

539.2

6028. Evaluation of diffusion of hydrogen into irc by observation of linear expansion of a sample. M Śmiałowski and Z. Szklarska-Śmiałowska. *Bu Acad. Polon. Sci. Cl.* 3, **1**, *No.* 3–4, 159–63 (1953).

The rate of absorption of nascent H_2 into the irc wire cathode at which it is produced by electrolysi was studied by measuring the elongation of the wi which such absorption produces: the effect on t rate was examined of various substances added t the electrolyte (N . H_2SO_4). Dibenzyl sulphoxid (0·16 g/litre), thiourea (1 g/litre) and As_2O_3 (1 g/litr produced, in this order, increasing rates of absorptio A. D. Le Clair

539.21

6029. Anelastic study on the diffusion coefficients o alpha-brass. N. Kunitomi. *Sci. Rep. Res. Inst Tôhoku Univ. A*, **5**, 335–42 (*Aug.*, 1953).

The anelastic relaxation in α-brass was measured i the temperature range from about 20 to 400°c, an the chemical diffusion coefficient was calculated fro these results by two different methods suggested b Le Claire and by Nowick. The comparison o diffusion coefficients thus obtained with those obtaine conventionally gave a criticism of these methods. I was seen from the comparison that the modifie Nowick's formula showed the best agreement an that Le Claire's formula would be improved if hi calculation was extended to a more detailed model. A

539.21

6030. Some predicted effects of temperature gradients on diffusion in crystals. A. D. Le Claire. Letter i *Phys. Rev.*, **93**, 344 (*Jan.* 15, 1954).

Criticizes a paper by Shockley [Abstr. 801 (1954)]. While a temperature gradient will always produce a mass flow of interstitials towards regions of lowe temperature, the direction of flow of vacancies depends on the relative magnitudes of their energy of forma tion U and the activation energy for their movement Q. If $U = Q$ there is no vacancy flow. When $Q > U$ the flow is towards high temperatures and when

$) < U$ towards low temperatures. Observations on he direction of mass flow will not then necessarily ive an unambiguous indication of the type of defect.
A. D. LE CLAIRE

539.217

031. The effect of temperature gradients on iffusion in crystals. J. A. BRINKMAN. Letter in *Phys. Rev.*, **93**, 345 (*Jan.* 15, 1954).

A criticism of Shockley's paper essentially the same s that of the preceding abstract. The experiments roposed by Shockley could be used to determine the rder of size of Q and U for materials in which diffuion is known from other evidence to occur via acancies.
A. D. LE CLAIRE

539.217

032. Some predicted effects of temperature radients on diffusion in crystals. W. SHOCKLEY. Letter in *Phys. Rev.*, **93**, 345–6 (*Jan.* 15, 1954).

While agreeing in principle with the criticisms of Le Claire and Brinkman (two preceding abstracts) the uthor considers they have overestimated the thermal diffusion contribution to the flow of defects.
A. D. LE CLAIRE

539.217

5033. Self-diffusion in germanium. H. LETAW, JR, L. M. SLIFKIN AND W. M. PORTNOY. Letter in *Phys. Rev.*, **93**, 892 (*Feb.* 15, 1954).

The diffusion of Ge^{71} in thin slabs of zone-melted single-crystal Ge was measured over a temperature range 780–930°c, 1 μC of Ge^{71} being plated on to two accurately ground faces. The diffusion coefficient $D = 87 \exp(-73\,300/RT)$ cm²/sec. The mechanism of diffusion as a motion of vacancies is discussed.
J. FRANKS

539.219

6034. On the precipitation of carbon from α iron. O. KRISEMENT. *Ark. Fys.*, **7**, *Paper* 27, 353–5 (1953) *In German.*

Thermal energy release measurements on 0·02% C iron yield values for the amounts of carbide precipitated in 20 min at various temperatures from 180°c to 230°c. Above 218°c precipitation is much slower and is attributed to formation of Fe_3C, whereas below this temp. it is Fe_2C, which is deposited.
W. M. LOMER

539.219

6035. A discussion of the factors affecting the constitution of zirconium alloys. P. C. L. PFEIL. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. M/R* 960, 35 *pp* (1953).

An attempt is made to extend existing alloy theory to zirconium. A forecast is made of the elements which may dissolve in the metal and attention is given to the probable influence on the allotropic transition. Discussion of the observed alloying behaviour of zirconium (*A.E.R.E. M/TN* 11) and of the behaviour of similar titanium alloys indicates that there is more than one factor operative in determining the effects of solute elements on the relative stabilities of the allotropes. A programme of experimental work to find out more about the factors governing the alloying behaviour of zirconium is suggested. The alloy systems with silver, aluminium, niobium and molybdenum appear to be of particular theoretical importance, while further information is required about zirconium–titanium alloys. 55 refs.
A.

539.234 : 539.181 : 778.33

6036. Radioactive-shadowing technique and note on the deposition of metal crystals from atomic beams. M. SIMNAD, LING YANG AND G. M. POUND. Letter in *J. appl. Phys.*, **25**, 268 (*Feb.*, 1954).

Autoradiographs of copper targets, which were set at 5° and 10° to a collimated beam of radioactive silver vapour, clearly showed the shadowing effects of steps 1/1000 in. high.
J. FRANKS

539.26 : 535.662

6037. X-ray study of colloidal coloured glasses. B. K. BANERJEE. *Proc. Nat. Inst. Sci. India*, **19**, 291–9 (*March–April*, 1953).

The nature of the colloidal particles of Au and Pt in glass samples of B_2O_3, borax and Lindemann glass and their influence on the structure of the glass have been investigated. The method of formation, vitreous limit, colour and the other interesting properties of the above glass systems are also discussed. X-ray photographs of the samples reveal the presence of broad lines of the noble metals besides the diffuse haloes of glass.
A.

539.26 : 535.662

6038. Colloidal coloured silica glass. B. K. BANERJEE. *Proc. Nat. Inst. Sci. India*, **19**, 491–4 (*July–Aug.*, 1953).

The method of formation, X-ray study, the influence of lead oxide (PbO) and the effect of prolonged heat treatment of colloidal coloured glass of Ag and Au in silicate glass base were studied.
A.

539.26 : 535.662

6039. Colloidal coloured silver glasses. B. K. BANERJEE. *Proc. Nat. Inst. Sci. India*, **19**, 495–500 (*July–Aug.*, 1953).

The state of existence of Ag in B_2O_3 borax and Lindemann glass and its influence on the structure of the glass base have been studied along with other interesting properties such as the method of formation, vitreous limit, colour, etc. Similarly AgCl–borax glass specimens have also been studied. In the course of the above investigation the crystallite of the dispersoid has been identified by the X-ray diffraction study.
A.

539.27

6040. Direct observation of solid surfaces at high resolution by reflection electron microscopy. J. W. MENTER. *J. photogr. Sci.*, **1**, 12–20 (*Jan.–Feb.*, 1953).

A standard commercial transmission electron microscope has been modified for the direct examination of solid surfaces at high resolution by reflection. The geometry, resolution, contrast and depth of focus of the images obtained are briefly discussed. An investigation has been made of the types of specimen which may usefully be studied by the method. It is pointed out that its main value lies in the examination of very flat surfaces, e.g. high mechanical and electropolish, cleavage faces, and surfaces on which there are isolated features, e.g. cleavage and growth steps, overgrowths, etc., and features too large to be within the depth of focus of the optical microscope

or within the range of transmission electron microscope replica methods. Among the specimens studied are cleavage features on zinc single crystals and mica, growth features on silicon carbide crystals, surface damage (scratches) produced by sliding. It is suggested that the method may be valuable for the examination of some biological specimens where replica methods are inappropriate. A.

539.27

6041. Electron diffraction study on the selective oxidation of copper–aluminium alloys. D. WATANABE, S. OGAWA AND T. KIMURA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 238–53 (*June*, 1953).

Copper–aluminium alloys containing $1 \sim 10\%$ of aluminium were selectively oxidized by Price's method, and surface films formed on them were examined by electron diffraction. The relations connecting the nature of the films with the treatment-temperature, the aluminium-content and the discoloration-resistance to various acids were elucidated. Diffraction patterns obtained in the range of the high discoloration-resistance did not correspond with the expected γ–Al_2O_3 but with those which Harrington *et al.* had previously obtained from a heated surface of an electro-polished aluminium, and they were considered to arise from one of the complicated modifications of aluminium oxide. When the original or heat-treated surfaces were heated in an oxidizing gas flame, the patterns obtained possessed, besides the rings of γ–Al_2O_3, a few extra ones which neither belonged to the f.c.c. lattice nor could be ascribed to reasonable impurities. After detailed consideration this fact led to the conclusion that the alumina obtained had a more complicated symmetry than γ–Al_2O_3 of the ordinary spinel type. When a specimen of 1% aluminium selectively oxidized was subsequently heated in an electric furnace, a break-up of Debye rings took place owing to the refraction effect of electrons due to minute crystals of cupric oxide. A.

539.27

6042. Electron microscopy of synthetic elastomer lattices. R. R. STROMBERG, M. SWERDLOW AND J. MANDEL. *J. Res. Nat. Bur. Stand.*, **50**, 299–309 (*June*, 1953).

The effects on the apparent particle size and its frequency distribution arising from the method of specimen preparation, shadowcasting, distortion of shape, and other artifacts inherent in the electron microscopy of synthetic elastomer lattices are described. The possibility of applying a single, reproducible method of examination to four lattices involving three copolymers (butadiene–styrene, butadiene–acrylonitrile, and butadiene–styrene–acrylonitrile) is statistically evaluated. These copolymers contain particles ranging in size from approximately 100 to 2100 Å, and their average particle diameters are about 600, 800, and 1700 Å, respectively. A.

539.27

6043. Dark field electron microscope method of identifying small crystals. O. RANG AND F. SCHLEICH. *Z. Phys.*, **136**, *No.* 5, 547–55 (1954) *In German.*

In order to identify the different crystals in a mixed specimen, a small aperture is introduced into the back focal plane of the objective lens to select the diffracted beam from each component in turn. In norm operation of the electron microscope, this bea produces a dark field image of the respective cryst By switching in a diffraction lens the back focal pla instead of the object is focused on the screen, so th the diffraction pattern becomes visible. In this w the pattern corresponding to each crystal can recorded and used to identify it. An example given in which MoO_2 and MoO_3 crystals in a mixtu were separately identified. The method is straigh forward so long as the probable constituents of t mixture are known. V. E. COSSLE

539.

6044. Applied electron microscopy. R. B. FISCHE *Bloomington: Indiana University Press* (1953) 234 xiii *pp.*

Review in *Rev. sci. Instrum.*, **25**, 79 (*Jan.*, 1954).

539.

6045. Titanium observed by electron diffracti S. YAMAGUCHI. Letter in *J. appl. Phys.*, **25**, 4 (*March*, 1954).

Interplanar spacings and intensities, obtained diffracting 200 kV electrons in titanium filings, a given. R. S. PEA

539.27 : 537.533.

Recent developments in electron microscopy. *S Abstr.* 5677

539.27 : 537.533.

Introduction to electron microscopy. *See Abs* 5676

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.3

6046. Determination of relaxation spectra fro damping measurements. F. C. ROESLER AND J. R. A PEARSON. *Proc. Phys. Soc.* [*London*] *B*, **67**, 338–4 (*April*, 1954).

A method is shown for the determination of th relaxation spectrum from the data furnished b dynamical experiments, and in particular from th damping (imaginary part of the complex modulus) a a function of frequency. The circular functions an eigenfunctions of the relevant integral equation, whic can therefore be solved numerically by expansion The spectrum is obtained by first making a Fourie analysis, multiplying every coefficient by the associate eigenvalue, and then synthesizing the new Fourie series. An estimate is given of the resolving power o the method, which is limited only by the error in th experimental data. As an illustration, the spectru of polyisobutylene in the frequency domain corre sponding to the rubber-glass transition is found fro published data. A

539.319 : 539.2

6047. X-ray investigation of internal strains due t bending in iron. E. KAPPLER AND L. REIMER. Not in *Naturwissenschaften*, **41**, *No.* 3, 60–1 (1954) *I German.*

Reports measurements of internal strains across cross-section of a plastically bent iron bar. By usin

th Co and Cr radiation it was possible to eliminate e effect of the surface of the specimen and to easure the strains due to anisotropy. A. E. DE BARR

539.32

48. The elastic constants and density of palladium ver alloys. F. E. HOARE AND B. YATES. Letter in *oc. Phys. Soc.* [*London*] *B*, **67**, 266–7 (*March*, 1954). Measurements of rigidity modulus by torsional cillation of a wire and of Young's modulus by rsion of a helical spring. Both curves show a aximum. The results are used to calculate a irve of Debye temperature *v.* composition, which oes not agree with direct specific heat measure- ents. W. M. LOMER

539.32 : 534.372

On the dissipative viscoelastic constants of higher der. *See Abstr.* 5389

539.32 : 535.417

049. The measurement of the Young's modulus of etals and alloys by an interferometric method. II. The influence of heat-treatment on the Young's oduli of Fe–Al alloys, and the Young's moduli of i–Al, Al–Cu alloys and German silver in the annealed ate. T. FUKUROI AND Y. SHIBUYA. *Sci. Rep. Res. sts Tôhoku Univ. A.*, **5**, 405–12 (*Oct.*, 1953).

For Pt II, see Abstr. 4399 (1953). The measurement escribed in Pts I and II has been extended to the tudy of the influence of heat-treatment on the Young's oduli of Fe–Al alloys having the composition up to 4·75% aluminium. It becomes clear that the Young's odulus of ordered Fe_3Al (13·8% aluminium) is maller than that of the disordered one. This result s contrary to the cases of Cu_3Au and Ni_3Mn. More- ver, measurement has been done on the static oung's moduli of Ni–Al alloys (up to 5·17% luminium), several specimens of Al–Cu alloys and erman silver. The Young's modulus *v.* composition urve of Ni–Al alloys seems to be akin to those of Ni alloys such as Ni–Cu and Ni–Mn systems. A.

539.373

6050. Etch pit attack on plastically deformed aluminium. P. J. E. FORSYTH. Letter in *Phil. Mag.*, **45**, 444–5 (*March*, 1954).

The tendency for etch pits to be aligned along slip bands [Abstr. 811 (1954)] disappears after the surface has been repolished, even if so lightly as still to leave undulations revealing the slip band positions.

A. D. LE CLAIRE

539.374

6051. Higher approximation methods for the relaxation spectrum from static and dynamic measurements of visco-elastic materials. F. SCHWARZL AND A. J. STAVERMAN. *Appl. sci. Res. A*, **4**, *No.* 2, 127–41 (1953).

It appears that better approximations are obtained when higher time-derivates of the moduli are measured. A chart showing quantitative relations between the accuracy of an approximation and the accuracy of various static and dynamic experiments is given. A.

539.374 : 536.7

6052. Thermodynamics of viscoelastic behaviour (model theory). A. J. STAVERMAN AND F. SCHWARZL. *Proc. K. Ned. Akad. Wetensch. B*, **55**, *No.* 5, 474–85 (1952).

The problem of calculating thermodynamic functions of visco-elastically behaving materials is treated by means of considerations on mechanical models. In simple relaxation or creep experiments the thermodynamic functions at time t depend on the relaxation or creep function at time $2t$. Formulae for the thermodynamic functions in general cases of prescribed strain and of prescribed stress are given. It turns out that models consisting of springs and dashpots connected by rigid side bars are thermodynamically equivalent whenever they are mechanically equivalent. This means that when two models are mechanically equivalent, not only the dependence of the forces and deformations on the time is identical, but also the amount of energy stored in the springs and dissipated in the dashpots. However, in order to reach this conclusion the mechanical equivalence of the models did not suffice, but certain physical properties of the links between the units had to be taken into account. Therefore the question whether or not the conclusions drawn from model-considerations are also valid for real viscoelastic materials, cannot yet be answered unambiguously. A.

539.374 : 536.7

6053. Non-equilibrium thermodynamics of visco-elastic behaviour. A. J. STAVERMAN AND F. SCHWARZL. *Proc. K. Ned. Akad. Wetensch. B*, **55**, *No.* 5, 486–92 (1952).

Linear visco-elastic behaviour is described as resulting from an arbitrary number of molecular processes proceeding in a sample which is subjected to visco-elastic deformations. Describing the course of the molecular processes by a set of quantities, ξ_i, indicating the degree of progress of the processes, and applying non-equilibrium thermodynamics, one can construct a set of molecular processes which behave independently in a relaxation experiment. From this description the physical meaning of the relaxation spectrum becomes clear at once: the intensity of the spectrum at a certain frequency is a measure for the contribution of the independent molecular process of that frequency to the elasticity moduli at very short times. Boltzmann's superposition principle can be derived from these thermodynamical considerations without further assumption. The course of free energy in visco-elastic deformations is shown to be in accordance with the results obtained with models. A.

539.374 : 539.434

6054. Studies on the creep recovery and annealing of zinc single crystals. M. TANENBAUM AND W. KAUZMANN. *J. appl. Phys.*, **25**, 451–8 (*April*, 1954).

Pt I is a description of some of the factors involved in the recovery by pure zinc single crystals at 35°C of the ability to creep following plastic deformation. The following observations were made: (1) Complete recovery of the ability to show an initial instantaneous plastic extension occurs much less readily than recovery of the ability to show transient creep. (2) Once the quasi-viscous creep stage is reached no recovery of transient creep occurs when the load is partially or completely removed for 2 min, but removal of only 6% of the load for 100 min permits partial recovery of transient creep at the full load. A 300 min "rest" at 91·5% of the full load resulted in complete recovery of the transient creep at full load, even though creep occurred at the reduced stress. (3) The recovery of

quasi-viscous creep at a reduced stress after exposure to a higher stress was also investigated. The recovery was slower, the larger the initial load. (4) The rate of the time-dependent contraction of zinc crystals on removal of the load probably follows a power law in the time. There is also an instantaneous non-elastic contraction which is about ten times larger than the elastic contraction. These results show that the role of thermal fluctuations in activating the units of flow is very different from the role of the stress. The applications of the Eyring rate equation to quasi-viscous creep which have been made in the past are, therefore, not valid. A variable activation energy must be postulated in order to account for the kinetics of creep and recovery. These results are interpreted in terms of the dislocation theory of plastic flow. In Pt II a phenomenon is described in which pure zinc single crystals are consistently found to become temporarily hardened by annealing in vacuum above 200–260°c. The hardness thus introduced can be removed by straining the crystal and then allowing it to stand at temperatures below 200°c. The crystal is in this way returned to its normal plastic state. The hardening is not removed by electropolishing the crystal, so is not a surface phenomenon. Though similar to Orowan's thermal hardening effect, it differs by requiring a much higher temperature and by not requiring the addition of impurities. A.

539.382.2

6055. The necking of a tension specimen in plane plastic flow. E. T. Onat and W. Prager. *J. appl. Phys.*, **35**, 491–3 (*April*, 1954).

A linearized version of the equations of plasticity is used to discuss the symmetrical necking of a tension specimen in plane plastic flow. The material is treated as perfectly plastic, and elastic strains are neglected. A.

539.4 : 548

6056. Effect of oxide films on the mechanical properties of cadmium monocrystals. V. I. Likhtman and V. S. Ostrovskiĭ. *Dokl. Akad. Nauk SSSR*, **93**, *No.* 1, 105–7 (1953) *In Russian.*

The yield point of a cadmium single crystal, having a 900 Å thick surface-film of oxide produced by heating at 230°c for 2 hours, is ~14% higher than that of an unoxidized sample, and the stress-strain curves exhibit a sharp drop of shear stress in the region of plastic deformation, an effect which increases with reduction in wire diameter. These effects are shown to be conditioned by the high strength of the oxide in thin films (~300 kg/mm²). R. C. Murray

539.4.016.2

6057. On the temperature-dependence of the work hardening of aluminium single crystals. K. Lücke and W. Staubwasser. Note in *Naturwissenschaften*, **41**, *No.* 3, 60 (1954) *In German.*

In tensile tests on high-purity Al single crystals at liquid air temperature the first 6% strain (easy glide) was not temperature-dependent. After 6% the work-hardening rate was much greater at the low temperature than at room temperature. W. M. Lomer

539.43

6058. The behaviour of aluminium deformed under alternating stresses. N. Louat and M. Hatherley. Note in *Proc. Phys. Soc.* [*London*] *B*, **67**, 260–1 (*March* 1954).

Slip occurs in the second half cycle on or near those planes which were operative in the first half cycle, but only at stresses considerably in excess of the maximum stress applied in the first half cycle.

A. D. Le Claire

539.501 : 539.43

6059. The rheological properties of dielectric polymers at frequencies from 1 kc/s–200 kc/s. W. Lethersich. *Rep. Brit. Elect. Res. Assoc.*, *Ref. L/T272*, 7 *pp.* (1952).

Creep was found to occur which is wholly elastic and can be represented by a system of Kelvin elements in series each having a relaxation time τ. It was shown that the distribution function of relaxation times is expressible in the form k/τ for values of τ ranging from 10^{-3} to 10^{4} sec. The tests described in this report extend the lower range to around 10^{-5} sec and the hyperbolic relation still holds although for ebonite the lowest relaxation time appears to be about 10^{-4} sec. Poisson's ratio is found to be much greater when measured under alternating stress than under constant stress. This can be attributed to a volume viscosity but this explanation is not wholly satisfactory as the coefficient of internal friction should be raised. No such increase is observed. See also Abstr. 1378 (1951). A.

539.533

6060. On the microhardness of aluminium single crystal. T. Hikage. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 254–62 (*June*, 1953).

The microhardness of aluminium single crystals in well-annealed state and its change in the course of deformation were measured with the microhardness tester newly designed by the author, the applied load being 8 g. It was found that in the well-annealed state the fluctuation of hardness was fairly large, and that in the hardness-strain curve two valleys existed, one in the range of the first yielding and the other in the neighbourhood of the outset of double slip. A.

539.6

6061. The strength properties and frictional behaviour of brittle solids. R. F. King and D. Tabor. *Proc. Roy. Soc. A*, **223**, 225–38 (*April* 22, 1954).

An experimental study has been made of the friction and strength properties of crystalline materials such as rock-salt, lead sulphide and ice. From frictional measurements on rock-salt and from estimates of the real area of contact during sliding, the specific shear strength of the material at the rubbing interface is calculated and found to be nearly seven times as great as the bulk shear strength of a rock-salt single crystal. It is suggested that this is because the material in the region of contact is under very high hydrostatic pressures. Independent compression experiments of rock-salt crystals confirm this. Under high hydrostatic pressures brittle fracture is prevented, marked plastic deformation occurs and the plastic yield-stress reaches values very much greater than the bulk shear strength of an uncompressed specimen. As with metals, the plastic yield stress of rock-salt may be correlated with its indentation hardness. Experiments also show that if two rock-salt specimens are pressed together between rigid anvils so that there is appreciable plastic flow, very marked adhesion occurs between the crystals

d the interface is almost as strong as a single crystal. addition, hardness measurements of the track rmed during sliding show that although there is me cracking and surface fragmentation the behaviour dominated by plastic deformation of the surface yers. These results, and similar ones obtained with her brittle materials, suggest that the frictional haviour of brittle solids is primarily due, as with etals, to local plastic flow and to strong interfacial lhesion at the regions of real contact. A.

539.62 : 531.72

062. The true contact area between solids. DYSON AND W. HIRST. *Proc. Phys. Soc.* [*London*] *B*, 7, 309–12 (*April*, 1954).

A new method for observing the points of real ontact between two solid surfaces is described. A etallized glass surface is pressed into contact with ne specimen, the glass surface being deformed locally t the points of contact. The opposite side of the etallized surface is examined through the glass by hase contrast microscopy, the deformations showing right on a dark background. Deformations of a ew Ångströms in depth are detectable if their lateral xtension is above the resolving limit of the microcope. Nominally flat, ground, polished, and lapped pecimens of silver steel have been examined. With ach specimen true contact was made within regions he sizes and distribution of which were determined by he general undulations of the surface and by the nagnitude of the applied load. The differences lay n the distribution of the local contact areas within he general regions. With the polished specimen true ontact was made over almost the whole of the general egion but with the ground specimen it was confined to a few isolated areas along the grinding ridges. True contact with the lapped specimens was made at a very great number of areas each a few microns in linear dimension. A.

539.67

6063. Internal friction of metal crystals due to vacancy pairs. R. R. HASIGUTI. Note in *J. Phys. Soc. Japan*, **8**, 798 (*Nov.–Dec.*, 1953).

It is proposed that vacancy pairs, because of the anisotropic lattice strain around them, can contribute to internal friction in the same way as solute atom pairs do in substitutional solid solutions [Abstr. 1356 (1947)]. That the internal friction of cold-worked Cu is larger than that of worked Al is attributed to such vacancy-pair damping, the density in Cu of vacancies produced by cold work and remaining at room temperature being higher than in Al.

A. D. LE CLAIRE

539.67 : 538.24

6064. On the internal friction of ferromagnetic substances. N. KUNITOMI. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 287–310 (*Aug.*, 1953).

The microscopic eddy current was calculated theoretically as a function of the magnetization and the results were compared with the experimental data obtained with the substances which have negligibly small anisotropic energy. Two different theories were developed under two assumptions on the generating mechanism of microscopic eddy current. The first theory, which assumes that the microscopic eddy current is induced by the rotation of the spontaneous magnetization, concludes that the relation between internal friction and magnetization is given by a curve with a maximum starting from a finite value at demagnetized state, while the second, assuming the displacement of the 180° magnetic domain boundary, concludes that internal friction is proportional to the square of the magnetization. To confirm these theoretical results, the following three series of measurements of internal friction were made using transversal vibration of about 500–1000 c/s: (1) The effect of superlattice formation on the internal friction of Ni_3Fe was observed and the results were well explained by considering both macro- and microscopic eddy currents. In this case, microscopic eddy current is considered to be induced by the rotation of the spontaneous magnetization. (2) Internal friction of the field-cooled Ni_3Fe was also explained by the microscopic eddy current due to the rotation of the spontaneous magnetization. (3) The behaviour of internal friction of 65-Permalloy showed remarkable difference from that of Ni_3Fe. It could be explained neither by considering the rotation of the spontaneous magnetization nor by considering the displacement of 180° domain boundaries, so that the other process must be introduced to explain the experimental facts. The internal friction of Perminvar shows intermediate character between Ni_3Fe and 65-Permalloy. It may be explained by considering both the rotation of the spontaneous magnetization and the other process which is responsible for the internal friction of 65-Permalloy. A.

PHYSICAL CHEMISTRY 541

541.1 : 535

6065. An advanced treatise on physical chemistry. Volume 4. Physico-chemical optics. J. R. PARTINGTON. *London: Longmans, Green and Co.* (1953) xl × 668 *pp.*

Review in *Nature* [*London*] **173**, 326 (*Feb.* 20, 1954).

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.2

6066. Gas-liquid phase equilibrium in the system methanol–hydrogen. A. MICHELS, W. DE GRAAFF AND J. VAN DER SOMME. *Appl. sci. Res. A*, **4**, *No.* 2, 105–8 (1953).

The liquid-gas phase equilibrium of the binary mixture methanol–hydrogen has been measured at the temperatures 25°, 50°, 75° and 100°c. The pressure ranged from 80–800 atm. The results are tabulated and also given in a diagram. A.

541.124

6067. Energies of interaction and other properties of clathrate compounds. D. F. EVANS AND R. E. RICHARDS. *Proc. Roy. Soc. A*, **223**, 238–50 (*April* 22, 1954).

Heats of formation of clathrate compounds of

β-quinol with argon, oxygen, nitrogen, hydrogen chloride, hydrogen bromide, formic acid and methanol have been determined calorimetrically. For the argon and oxygen compounds, the heats of formation were determined for samples of widely differing composition, and they vary linearly with the fraction of available spaces filled. Using the energy difference between α- and β-quinol obtained directly or by extrapolation of the measurements on the argon and oxygen compounds, the energies of interaction of the enclosed molecules with the β-quinol cage have been determined. Their values are interpreted in terms of the polarizabilities of the enclosed molecules and the number of intermolecular contacts occurring. The free energies of formation, and the colours of the sulphur dioxide and oxygen clathrate compounds are also discussed briefly. A.

541.124 : 537.52

6068. Studies on the discharge reaction in liquid air. I. On the discharge reaction products. E. KANDA AND Y. NOMURA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 1–7 (*Feb.*, 1953).

Applying high tension from an induction coil or from a transformer, discharge reactions in liquid air were studied. The reaction products were examined by vapour pressure method, that is, by comparing the vapour pressure curves of the products with those of known compounds. The results varied with the kinds of high tension sources and were very different from those of other authors; especially, the yield of ozone varied markedly with the current intensity and type of discharge. By raising the temperature after discharge, reactions and products were investigated. NO_2 or $(NO_2)_2$, nitrogen trioxide and N_2O_5 were ascertained. An explosion due to decomposition of ozone often occurred at about −100°C. The green coloured solid product was supposed to be a mixture of $(NO_2)_2$ and nitrogen trioxide. A higher oxide of nitrogen such as NO_3 was not obtained in the reaction. A.

541.124 : 537.52

6069. Studies on the discharge reaction in liquid air. II. On the thermal secondary reaction. Y. NOMURA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 8–15 (*Feb.*, 1953).

The thermal reactions under discharge and reactions between the discharge reaction products during the rise of temperature after discharge were discussed. The green product of the discharge reaction was compared with the product of the similar colour obtained by passing NO into liquid oxygen, and the difference between them was ascertained. The compound such as NO_3 or N_3O_4, which had been believed by other authors to be a product of the latter reaction, was not detected. A.

541.126 : 536.71

6070. Equations of state and detonation theory. S. PATERSON AND J. M. DAVIDSON. Letter in *J. chem. Phys.*, **22**, 150 (*Jan.*, 1954).

The Cottrell–Patterson equation of state yields values of the detonation velocity in PETN in good agreement with experiment except when the heat of reaction is low at low loading densities, probably because intermolecular attractions are neglected. The Lennard–Jones/Devonshire equation gives velocities which are consistent with those calculat by Murgai [Abstr. 8734 (1953)]. Better agreeme with experiment can be obtained by using a (9, instead of (12, 6) potential for nitrogen in the equati of state. R. C. MURR

541.1

6071. Rates of formation of different deuteroethylen and deuteroethanes in the reaction of ethylene a deuterium. T. KEII. Letter in *J. chem. Phys.*, 2 144–5 (*Jan.*, 1954).

The fact that the ethanes formed from ethylene a deuterium over nickel at 90°C are mainly C_2H_6 explained by Horiuti's theory of ethylene hydrogen tion. Here the fine structure of the reaction developed in order to explain the observed facts greater detail. Theoretical predictions are ma about the relative proportions of the various produc at temperatures away from the optimum.

A. J. TAYL

541.1

6072. Formulation of the rate equation in chemica kinetics. P. V. DANCKWERTS. Letter in *Natu* [*London*] **173**, 222 (*Jan.* 30, 1954).

The conventional equation relating concentration and their rates of change relates to closed syste which are tacitly assumed to be at constant volum A less restricted form of the equation is given whi is useful for closed systems involving volume charges and open (e.g. continuous-flow) systems in which th concentrations are time-independent; such a syste must have a constant atomic content, and be virtuall uniform in temperature and composition.

A. J. TAYLO

541.12

6073. Kinetics of the fast gas phase reaction betwee ozone and nitric oxide. H. S. JOHNSTON AND H. J CROSBY. *J. chem. Phys.*, **22**, 689–92 (*April*, 1954).

The rate of reaction was followed optically at −4 and −75°. The reaction appears to be elementary bimolecular $NO + O_3 = NO_2 + O_2$ and the rat constant is $k = 0{\cdot}8 \times 10^{12} e^{-2500/RT}$ cc mole^{-1} sec^{-1} The pre-exponential factor for this reaction is com pared with those of six other elementary gas phase reactions of the type $X + Y = Z + W + \ldots$ in volving the oxides of nitrogen for which the energies of activation were higher. For this series of similar reactions the molecular complexity of the reactants is about constant (five or six atoms), and there appears to be no systematic difference in pre-exponential factor between the fast and the slow reactions. A.

541.127 : 539.155.2

6074. Carbon-13 isotope effect in the thermo-decomposition of nickel carbonyl. R. B. BERNSTEIN. *J. chem. Phys.*, **22**, 710–13 (*April*, 1954).

541.128 : 539.133

6075. The ortho-para conversion of hydrogen and deuterium on inhomogeneous paramagnetic surfaces. Y. L. SANDLER. *Canad. J. Chem.*, **32**, 249–60 (*March*, 1954).

The kinetics of the magnetic ortho–para conversion of hydrogen and deuterium on neodymium oxalate and hemin crystals has been determined over a wide temperature range in a static system. In these cases

imilar type of rate curve is obtained: at high and low temperatures the rate decreases with tempera-e, while in the intermediate region the rate in-ases with temperature. The behaviour is explained erms of an energetic surface heterogeneity. In case neodymium oxalate two distinctly different groups sites appear to be active having energy barriers to gration of the adsorbed hydrogen at considerably ferent height. The conversion mechanism of the apped" gas is assumed to be similar to the chanism in liquids where repeated collisions are o assumed to occur. A.

ELECTROCHEMISTRY 541.13

541.133

076. Conductivities of polyelectrolyte solutions at gh frequencies. C. S. CHADWICK AND S. M. NEALE. *ature* [*London*] **173**, 493 (*March* 13, 1954).

The conductivity of aqueous solutions of sodium olymethacrylate is found to begin to increase at a equency of about 0·1 Mc/s. This is much lower an for a solution of KCl of the same concentration. n explanation is given. W. GOOD

541.134 : 536.252

077. Thermal diffusion potentials and the Soret fect. H. J. V. TYRRELL AND R. COLLEDGE. Letter *Nature* [*London*] **173**, 264–5 (*Feb.* 6, 1954).

By measuring the e.m.f. of the cell

$$\text{g}\left|\text{AgNO}_3,\ \text{molality}\left(m-\frac{\Delta m}{2}\right)\right.\Big\|\ \begin{matrix}\text{at } T^\circ\\ \text{AgNO}_3,\ \text{molality}\left(m+\frac{\Delta m}{2}\right)\\ \text{at } T+\Delta T^\circ\end{matrix}\ \Big|\text{Ag}$$

ie difficulty of verifying the theoretical expression iving the change in e.m.f. during the establishing of ie Soret equilibrium is overcome. W. GOOD

541.135

078. On a consistency test of the theories of strong lectrolytes in solution. M. SENGUPTA. *Indian J. hys.*, **27**, 628–32 (*Dec.*, 1953).

In the original Debye–Hückel theory the Poisson quation has been evaluated on the assumption that $e^{-\epsilon\psi/kT} = 1 - \epsilon\psi/kT$, i.e. $\epsilon\psi/kT \ll 1$. In this paper is shown that the value of $\epsilon\psi/kT$ with which the ctual thermodynamic calculations have been made n the theory, is generally >1. Thus at least in this espect the original calculations of Debye and Hückel re inconsistent. Incidentally, a similar test applied o the theory of Bagchi shows that this theory is enerally consistent in this respect. A.

541.135.5

079. Potentiostat for use in electro-chemical xperiments. G. SCHOUTEN AND J. G. F. DOORNE-AMP. *Appl. sci. Res. B*, **3**, *No.* 4–5, 265–78 (1953).

In many electro-chemical experiments it is desirable hat one of the current-carrying electrodes of an lectrolytic bath has a constant potential. This may e realized by manual control of the bath current. Owing to the sudden and unpredictable potential fluctuations of the electrode concerned, this is very difficult and even impossible in some special cases, e.g. when passivating an Fe-electrode in aqueous H_2SO_4. In addition there may be a considerable time-lag between the potential and the current fluctuations. The different types of potentiostats described so far seem to have too large a time-lag and/or too low a sensitivity for this purpose. The authors describe a potentiostat with proportional and integrating properties resulting in a stabilization of the potential within $\frac{1}{2}$ mV in favourable sections of the potential current characteristic. Even with an electrode with a very steep potential current characteristic (e.g. the above-mentioned Fe-electrode) the ripple never exceeds a few mV. The bath current, the maximum value of which is 30 mA, is the differential current of two electronic tubes. This type of circuit offers various advantages. A.

541.135.5

6080. Effect of temperature on the electrical resistance and voltage departures (errors) of glass electrodes, and upon the hygroscopicity of glass. D. HUBBARD. *J. Res. Nat. Bur. Stand.*, **50**, 337–42 (*June*, 1953).

The effect of temperature upon the electrical resistance and pH response was studied on electrodes prepared from three types of glasses: Pyrex 7740, commercial soft-glass tubing, and Corning 015; glasses of low, intermediate and high hygroscopicity, respectively. The results show that electrical resistance is not the determinant in most cases of voltage departure from the theoretical, and in the inherent failure of many glasses to act as satisfactory indicators of hydrogen-ion activity of aqueous solutions. For example, the electrodes prepared from Pyrex glass gave no significant pH response even when the resistance was as low as 12 megohms. The results of electrodes from glasses of intermediate hygroscopicity gave a pseudo-correspondence of pH response with resistance, whereas electrodes of Corning 015 gave voltage departures that could in no way be attributed to the electrical resistance of the electrode. A.

541.136.22 : 621.352

6081. The behaviour of standard cells in conditions which include the generation of appreciable current. L. HARTSHORN AND F. A. MANNING. *J. sci. Instrum.*, **31**, 115–18 (*April*, 1954).

Standard cells of the saturated type and ordinary H-pattern are capable of delivering a current of 1 μA continuously for a period of several months, a current of 10 μA for several weeks, and larger currents for shorter periods without undergoing any permanent loss of accuracy. While the current is flowing the voltage across the terminals of the cell is less than the e.m.f. as normally measured in the steady state by an amount which consists mainly of the resistive potential-drop but which includes also a component ΔV depending on the chemical changes at the electrodes associated with the generation of the current. This latter component is, in general, greater the larger the current, and increases with the time of flow. When the current is stopped the voltage rises to a value which is short of the steady-state e.m.f. by an amount ΔE, which is smaller than ΔV but of the same

order. If the cell is left undisturbed on open circuit, ΔE gradually diminishes until the steady-state e.m.f. is again reached, the time required for complete recovery depending on the magnitude and duration of the preceding current-flow. Values of these quantities for typical cells under a wide variety of conditions are given, with the object of providing a guide to the voltage-stability and working life that may be expected of cells operated within this range of conditions. A.

PHOTOCHEMISTRY. RADIATION CHEMISTRY 541.14/.15

541.14

6082. Reaction of cyclohexane with mercury-6($^3P_1$) atoms. P. W. Beck, D. V. Kniebes and H. E. Gunning. *J. chem. Phys.*, **22**, 672–7 (*April*, 1954).

An investigation has been made of the mercury-6($^3P_1$)-photosensitized decomposition of cyclohexane at 29·30 ± 0·01°c under static conditions. The products of the reaction are hydrogen, bicyclohexyl and cyclohexene, in order of decreasing importance. The mean quantum yields of cyclohexane disappearance, hydrogen formation and cyclohexene formation were found to increase slightly with increasing substrate pressure; at 90 mm cyclohexane pressure, the values are 0·83, 0·43 and 0·03, respectively. Extrapolation to initial conditions of data on the variation of mean quantum yield with time at constant substrate pressure gave 0·55 for the initial quantum yield of hydrogen formation, and 0·17 for cyclohexene formation, independent of substrate pressure. From the foregoing initial quantum yield data, taken in conjunction with the stoichiometry of the reaction, a value of 0·93 was obtained for the initial quantum yield of cyclohexane consumption. Absence of hexane, dodecanes, *n*-hexylclohexane and low molecular weights products was taken as evidence of the stability of the cyclohexane ring during reaction. The results of the investigation can be adequately accounted for by the following simple mechanism: (1) cyclo C_6H_{12} + Hg $6(^3P_1) \rightarrow$ cyclo C_6H_{11} + H + Hg $6(^1S_0)$, (2) H + cyclo $C_6H_{12} \rightarrow H_2$ + cyclo C_6H_{11} (3) 2 cyclo $C_6H_{11} \rightarrow$ cyclo C_6H_{10} + cyclo C_6H_{12}, (4) 2 cyclo $C_6H_{11} \rightarrow$ bicyclo $C_{12}H_{22}$, (5) H + cyclo $C_6H_{10} \rightarrow$ cyclo C_6H_{11}. Steps (1) to (4) describe the reaction under initial conditions. From the initial quantum yield data the ratio k_4/k_3, the ratio of the rates of recombination to disproportionation for cyclohexyl radicals, was evaluated at 2·2. In short, recombination is approximately twice as fast as disproportionation for cyclohexyl radicals. A.

541.14

6083. Further studies on the reaction of cyclopentane with mercury-6($^3P_1$) atoms. P. W. Beck, D. V. Kniebes and H. E. Gunning. *J. chem. Phys.*, **22**, 678–80 (*April*, 1954).

A further investigation has been made of the reaction of cyclopentane with Hg$6(^3P_1)$ atoms at 29·30 ± 0·01°c, under static conditions. Analyses, using mass spectrometric techniques, confirm that the only direct products of the reaction are hydrog bicyclopentyl and cyclopentene. No evidence found for decomposition of the cyclopentane r The kinetics of the reaction can be satisfacto explained in terms of the following general mech ism: (1) cyclo C_nH_{2n} + Hg$6(^3P_1) \rightarrow$ cyclo C_nH_{2n-} H + Hg$6(^1S_0)$, (2) H + cyclo $C_nH_{2n} \rightarrow H_2$ + cy C_nH_{2n-1}, (3) 2 (cyclo $C_nH_{2n-1}) \rightarrow$ cyclo C_nH_{2n-} cyclo C_nH_{2n}, (4) 2 (cyclo $C_nH_{2n-1}) \rightarrow$ bicyclo $C_{2n}H_{4n}$ (5) H + cyclo $C_nH_{2n-2} \rightarrow$ cyclo C_nH_{2n-1}. React (5) can be ignored at high substrate pressures or extents of decomposition. The limiting high-press values for the quantum yields of cyclopentane appearance, hydrogen formation and cyclopent formation are 0·90, 0·49 and 0·078, respectiv From the steady-state treatment of the mechan coupled with the quantum yield data, the ratio k_4 the ratio of the rates of recombination to dispro tionation for cyclopentyl radicals, was determined be 5·3.

541

6084. The decomposition of solid azides by elect bombardment. J. M. Groocock and F. C. Tompkin *Proc. Roy. Soc. A*, **223**, 267–82 (*April* 22, 1954).

The decomposition of barium and sodium azide room temperature brought about by electr bombardment using accelerating potentials of 100 200 V and also the effect of short-period p bombardment on the rate of the subsequent therm decomposition of the barium salt has been studi Although many characteristics of the reaction similar to those obtained in previous investigatio [Abstr. 2017 (1953)] using ultraviolet light, there some marked differences. These are attributed to t higher energies used in the primary beam so th "free" electrons and not excitons are produced a to the large excess of electrons always available duri bombardment. The theory proposed previously explain the effects of pre-irradiation and prolong photolysis, can, however, be extended to take in account these differences, and thereby provide adequate mechanism of decomposition.

541.

6085. The degradation of cellulose by ionisi radiation. A. Charlesby. *Atomic Energy Re Establ.* [*Harwell*] *Rep. M/R* 1342, 5 *pp.* (1954).

When subjected to the effect of ionizing radiatio such as atomic pile radiation or γ-radiation, cellulo is rapidly degraded into a powdery material. theoretical treatment shows that if the effect radiation is to cause fracture at random in the ma chain, the relation between intrinsic viscosity $[\eta]$ a radiation dose R should be of the form $\log [\eta]$ $- \alpha \log (R + R_0)$ + constant, where R_0 is a "virtua radiation dose needed to produce the initial numbe average molecular weight from a chain of infini molecular weight. The published data of Saema Millett and Lawton have been used to verify th formula, which leads to a relationship between $[\eta]$ cupriethylene diamine and viscosity average molecul weight M_v $[\eta] = KM_v^{\alpha}$, with $\alpha = 0{\cdot}71$. The consta K has been evaluated by comparison with data give by Gralen, but is less accurately known. It is deduce that one million rontgen results in fracture of 0·16

e monomer units in the main chain. The decom-
ion of carbohydrates under radiation, which
rs at the same time as main chain fracture, can
xplained on the assumption that approximately
monomer unit is decomposed per main chain
ure. The study of intrinsic viscosity of irradiated
mers appears to offer an accurate means of
uating α in the usual formula for intrinsic
osity $[\eta] = KM^{\alpha}$. A.

541.15

6. **Rotating sector method applied to reactions ced by Co^{60} gamma rays.** R. W. HUMMEL, G. R. MAN, A. B. VAN CLEAVE AND J. W. T. SPINKS. *nce*, **119**, 159–60 (*Jan.* 29, 1954).

n apparatus permitting intermittent illumination samples with γ-rays from a 1000 curie cobalt ce is described, and the results of intermittent diation of aqueous chloral hydrate and of chloro- n saturated with water are shown graphically. y indicate that the average free radical chain life- es in these systems are approximately 0·1 sec and c respectively. C. B. ALLSOPP

541.15

7. **Gamma-ray polymerization of acrylamide in solid state.** R. B. MESROBIAN, P. ANDER, D. S. LANTINE AND G. J. DIENES. Letter in *J. chem. s.*, **22**, 565–6 (*March*, 1954).

Acrylamide was irradiated by Co^{60} γ-rays 0 000 rep/hr). Rate curves are given for several peratures below the melting point, and a table ws the molecular weight characteristics of polymer med at various conversions, and the progressive rease in intrinsic viscosity with conversion. D. V. MABBS

DISPERSIONS . COLLOIDS. ADSORPTION 541.18

541.18.043

8. **The determination of concentrations in the racentrifugation of two-component systems.** R. AUTMAN, V. N. SCHUMAKER, W. F. HARRINGTON D H. K. SCHACHMAN. *J. chem. Phys.*, **22**, 555–9 *larch*, 1954).

An analysis of mass distribution in the ultra- ntrifugation of mixtures of two sedimentable mponents has been made. This treatment predicts e magnitude of the slow component concentration the region between the slow and fast boundaries well as the change in this concentration during the n. The theory has been applied to a series of xtures and is in agreement with the experimental ta. The existence of convection during the ultra- ntrifugation of mixtures is briefly discussed as well the application of the theory to a determination of ncentrations in unknown systems. A.

541.182.2/.3 : 537.24

9. **A new method for the measurement of aerosol ctrification.** B. L. HINKLE, C. ORR, JR, AND J. M. ALLAVALLE. *J. Colloid Sci.*, **9**, 70–80 (*Feb.*, 1954).

Because of the importance of the electrical forces associated with aerosol particles, an electrification analysis apparatus permitting rapid evaluation of the amounts of negatively and positively charged particles in an aerosol by measurement of the lateral deflection of the aerosol stream in an electrical field has been developed. Results obtained thus far have been in excellent agreement with expectation and with the published data of other investigators. The principal advantages of the method presented are the rapidity and ease of obtaining data and the elimination of the need for numerous samples to give statistically accurate results. An equation is presented for the calculation of the average electron charge carried by particles. A.

541.182.4 : 532.5

6090. **The flow of emulsions. II.** E. G. RICHARDSON. *J. Colloid Sci.*, **8**, 367–73 (*June*, 1953).

For Pt I, see Abstr. 1441 (1951). The conclusions to be drawn from the work described in this paper are: (1) The apparent viscosity of emulsions having the same concentration and the same size distribution about a mean globule diameter is inversely proportional to this mean diameter. (2) The observed variations of viscosity of a concentrated emulsion with concentration and rate of shear can be explained in terms of the work done in distorting the globules and sliding them past each other. A.

541.182.4 : 537.36

6091. **The mechanism of the resolution of water-in-oil emulsions by electrical treatment.** C. A. R. PEARCE. *Brit. J. appl. Phys.*, **5**, 136–43 (*April*, 1954).

When water-in-oil emulsions and many other suspensions are placed in a direct or alternating electric field the droplets or particles line up into chains in the direction of the field and, in the case of emulsions, the droplets may then coalesce and the phases separate. The alinement of the droplets is discussed in terms of the forces between conducting spheres in a field and it is suggested that their coalescence is caused by the force due to electrical charges on them or the electrical breakdown of the thin layer of dielectric separating them. According to these views it should be difficult if not impossible to dehydrate fine stable emulsions completely by the electrical method. A.

541.183

6092. **Adsorption of vapours on a mercury surface.** B. P. BERING AND K. A. IOĬLEVA. *Dokl. Akad. Nauk SSSR*, **93**, *No.* 1, 85–8 (1953) *In Russian.*

The plot of surface tension of mercury, measured by the max. bubble pressure method, against relative pressure of the vapour with which it is in contact, coincides with that obtained by Kemball [Abstr. 445 (1947)] for *n*-heptane, but differs sharply from his plots for water and methyl alcohol even in shape (the authors' curves are convex, Kemball's concave, to the relative vapour pressure axis). The difference is ascribed to contamination of the surface of the mercury by material extracted from the glass in the protracted measurements of drop size by Kemball's procedure. This convexity indicates strong attractive forces between adsorbed molecules, presumably through hydrogen bonding. R. C. MURRAY

541.183 : 536.75

6093. Entropy and mobility of adsorbed molecules. I. Procedure; atomic gases on charcoal. J. H. DE BOER AND S. KRUYER. *Proc. K. Ned. Akad. Wetensch. B*, **55**, *No.* 5, 451–63 (1952).

The procedure, using adequately chosen standard states for the ideal models is explained and applied to the adsorption of argon, helium and mercury on charcoal (and graphite). The adsorption of argon on charcoal at a temperature above 200°K may be described as a "super-mobile" adsorption, which means that in transferring the atoms from the gas to the adsorbed state two degrees of translational freedom are retained whilst the third is substituted by a vibration perpendicular to the surface, having such a frequency ($\nu > 10^{-14}$ sec^{-1}) that it still contributes towards entropy. At temperatures between 80°K and 125°K the adsorption of argon may still be described as that of a two-dimensional gas. The movements of the adsorbed atoms are slightly restricted. At temperatures lower than 70°K adsorbed argon on graphite condenses two-dimensionally when the degree of occupation increases to about 0·4. The adsorption of helium on charcoal at 19·37°K may be described with a model of "hopping molecules." The adsorption of mercury atoms on charcoal at 666°K is another example of "super-mobile" adsorption. A.

541.183 : 536.75

6094. Entropy and mobility of adsorbed molecules. II. Nitrogen on charcoal. J. H. DE BOER AND S. KRUYER. *Proc. K. Ned. Akad. Wetensch. B*, **56**, *No.* 1, 67–74 (1953).

The adsorption of nitrogen molecules on charcoal at temperatures between −80°C and 0°C leads to the formation of a two-dimensional gas. The nitrogen molecules move freely over the surface and have not lost their freedom of rotation. At higher temperatures the adsorbed nitrogen molecules have an additional degree of freedom, their vibration with respect to the charcoal surface as a whole contributes somewhat to entropy. They, therefore, show a certain degree of super-mobility. At low temperatures—down to 84°K—and at high degrees of occupation, there is a certain restriction of the free translation of the nitrogen molecules over the surface. The rotation of the molecules, however, is not hindered. There is, therefore, no mutual orientation. A.

541.183.24

6095. Adsorption studies on clay minerals. IV. The system montmorillonite-cesium-potassium. J. A. FAUCHER AND H. C. THOMAS. *J. chem. Phys.*, **22**, 258–61 (*Feb.*, 1954).

For Pt II, see Abstr. 4436 (1953). The ion-exchange equilibria between a montmorillonite clay and potassium-caesium from chloride solutions have been studied by chromatographic and other methods. The results are summarized in terms of equilibrium constants and activity coefficients for the mixed lay phase. A tentative discussion is given of the rate of the exchange process, particularly as it affects the behaviour of the chromatographic columns. A.

541.183.26 : 537.542

A low-pressure counter for measurements of gaseous adsorption of solids. *See Abstr.* 5726

541.18

6096. Charge-transfer no-bond adsorption of i atoms or molecules on metals. J. C. P. MIGNO Letter in *J. chem. Phys.*, **21**, 1298 (*July*, 1953).

Both Xe atoms and simple hydrocarbon molec when adsorbed on several metals are strongly polari with the positive charge outwards, i.e. the adsor particle is the donor. It is shown that this is to expected on theoretical grounds. S. J. GRE

CHEMICAL STRUCTURE 541.2/.6

541.

6097. The atomic weight of lithium from density X-ray data. D. A. HUTCHISON. *J. Amer. Chem. S* **76**, 967–9 (*Feb.* 20, 1954).

The atomic weight of lithium has been calcula from density and X-ray data to be: $M_{Li} = 6{\cdot}936$ 0·0018. This is less than the commonly accep value of 6·940. A critical evaluation of previ work does not preclude the present value.

541.24 : 535

6098. Light scattering by tobacco mosaic vi nucleic acid. T. G. NORTHROP AND R. L. SINSHEIM *J. chem. Phys.*, **22**, 703–7 (*April*, 1954).

The molecular weight of ribonucleic acid separa from tobacco mosaic virus by heat denaturation the protein has been measured by light-scatter techniques and found to correspond to the weight all the nucleic acid in a virus rod. The nucleic ac disintegrated rapidly at room temperature, m probably by enzymatic action.

541.25 : 535.

6099. Calculation of partial molar volume at infin dilution from refractive index measurements. A. SIRCAR AND S. R. PALIT. *Indian J. Phys.*, **27**, 610– (*Dec.*, 1953).

A method for the determination of partial speci volume $(\bar{v}_2)_0$ or the partial molar volume $(\bar{V}_2)_0$ infinite dilution from refraction measurements on with no solution density measurements, has bee proposed. The equation, $(V_2)_0 = 1/r_1\{v_1R_2 - 6M_2\gamma_0 n[(v_1)(n_1^2 + 2)]^2\}$ has been deduced, and ca culated values of $(\bar{V}_2)_0$ obtained from this equatio with a few recent data of n_D and d are found to be quite good agreement with observed ones.

541.4 : 539.1

On the relation between the chemical reactivity a energy levels of the chemical reagent. *See Abstr.* 584

LABORATORY APPARATUS 542.1/.7

542.41 : 621.365

6100. Making laboratory electric furnaces. L. H BARRETT. *Research*, **6**, 61–7 (*Feb.*, 1953).

Various types of electric furnace which are suitab for laboratory purposes are described, and th

nciples involved in their construction are dealt th briefly. A.

542.7

01. A method to remove hydrogen from inert ses. Z. Dokoupil, K. W. Taconis, D. H. N. ansink and J. J. M. Beenakker. *Appl. sci. Res. A*, *No.* 1, 57–60 (1953).

A simple apparatus for removing hydrogen from her large quantities of incombustible gases (several /hr) is described. In the apparatus the hydrogen burnt to water by means of a platinum or nichrome candescent wire after adding an excess of oxygen. ne gases, neon and helium, which are purified in this ay do not contain any measurable quantity of drogen. A.

CHEMICAL ANALYSIS 543/545

545.8

102. The determination of dysprosium in holmium xide by radioactivation analysis. G. Phillips and . W. Cornish. *Atomic Energy Res. Establ.* [*Harwell*] *ep. C/R*1276, 4 *pp.* (1953).

The dysprosium content of "Specpure" holmium xide has been determined by radioactivation analysis ithout chemical separation. The composite decay urve for the sample after neutron irradiation has been esolved by calculation from the experimental points. Dilution of the sample by grinding with sucrose in the olid state has been shown to lead to an inhomogene- ous mix compared with aqueous dilution. Two eries of experiments have been carried out using queous solutions; liquid counting gave 11·71 ± ·09% Dy in Ho_2O_3 whilst solid counting gave 11·66 ± 0·16% Dy in Ho_2O_3. The error limits efer to standard deviation of the mean. A.

545.8

6103. The determination of niobium in stainless steel. G. W. C. Milner and A. A. Smales. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. C/R*1311, 6 *pp.* (1954).

A procedure is described for the determination of the niobium content of stainless steels in which the niobium is first separated from many of the other steel constituents by precipitation with tannin and cinchonine from a slightly acid solution. The niobium concentration is finally determined absorptiometrically using the yellow coloration given with potassium thiocyanate. For accurate work it is necessary to incorporate Nb^{95} tracer to correct for small losses of niobium occurring in the chemical separation. However, the results obtained in the absence of radioactive niobium are generally satisfactory for the purpose of quality control. The determination of tantalum by radioactivation on the separated mixed earth acid oxides is also briefly discussed. A.

545.827

6104. The determination of the D_2O content of heavy water by a mass spectrometer. P. Reynolds and B. A. Loveridge. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. GP/R*1282, 13 *pp.* (1953).

The determination of the D_2O content of samples of heavy water containing approximately 99·7% D_2O is described. Deuterium in equilibrium with the water is analysed for its hydrogen content by means of a mass spectrometer. This instrument, which is fully described, is of simple construction, easy to operate and suitable for the routine analysis of samples. The overall precision of measurement is ±0·01% D_2O. Results are compared with those obtained for the same samples using an infrared absorption method. A.

545.827

6105. The extent of the fast neutron effect on the determination of sodium in aluminium by activation in the Harwell pile. L. Salmon. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. C/R*1324, 3 *pp.* (1954).

Upon irradiation of aluminium in the centre of BEPO, the reaction $_{13}Al^{27}(n:\alpha)_{11}Na^{24}$ takes place thus introducing spurious sodium activity when determining the sodium content of aluminium. This is shown to be equivalent to 81(±6%) p.p.m. of sodium in aluminium. A.

545.827 : 539.16.08

6106. The radiometric assay of uranium and thorium ores. E. Franklin and R. K. Barnes. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. EL/R*1175, 23 *pp.*; *Appendices*, 16 + xi *pp. and* 3 *plates.*

Various purely radiometric methods are described. Some are applicable only to ores containing either uranium or thorium separately, and some can be used when a mixture of the two is present in one ore. Methods are discussed also of dealing with ores in which the radioactive constituents are not present in their equilibrium proportions. A.

545.827 : 539.16.08

6107. Radium determination by alpha counting. H. W. Kirby. *Analyt. Chem.*, **25**, 1238–41 (*Aug.*, 1953).

A method is described which reduces the amount of labour and equipment involved in the assay of carrier-free radium and improves the precision and accuracy of the determination. A dilute HCl solution of the radium sample is passed through a short column of copper powder to remove polonium. The effluent is mounted on glass disks and α-counted 4 to 5 hours after mounting. Twenty-four hours after mounting, the samples are counted again and the percentage increase in counts is used to determine a correction factor for the growth of radon and its daughters. A sample certified by the National Bureau of Standards as containing 100 ± 0·7 μg of radium was found to contain 99·7 ± 0·6 μg when analysed by the method described. The method is applicable to radium stock solutions and other samples of radium which are relatively carrier-free. A.

CRYSTALLOGRAPHY 548

548.0 : 536.413

6108. Thermal expansion of copper sulphate. A. K. SREEDHAR. *J. Indian Inst. Sci. A*, **35**, 17–24 (*Jan.*, 1953).

The expansion ellipsoid of a triclinic crystal, $CuSO_4$, $5H_2O$ was determined. The necessary theory and the procedure to be followed in the case of triclinic crystals are given. The principal coefficients of expansion are: $41{\cdot}68\times10^{-6}$, $29{\cdot}27\times10^{-6}$ and $4{\cdot}45\times10^{-6}$. A.

548.2

6109. Light figures of bismuth single crystals and the determination of their crystal orientations by the light-figure method. II. Light figures. M. YAMAMOTO AND J. WATANABÉ. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 124–34 (*April*, 1953).

For Pt I, see Abstr. 4462 (1953). Light figures produced by bismuth single crystals etched with various reagents were observed and their suitability to the determination of crystal orientations by the light-figure method was examined. Light figures could be observed on bismuth crystals etched only with strongly oxidizing acids such as nitric acid and *aqua regia*. Distinct $\{111\}$, $\{uu\bar{v}\}$ and $\{uuw\}$ light figures obtained by etching for several minutes with 50% aqueous solution of 1 : 2 mixture of hydrochloric acid and nitric acid were found to be most suitable for the perfect orientation determination of bismuth crystals. A.

548.2

6110. Light figures of bismuth single crystals and the determination of their crystal orientations by the light-figure method. III. Orientation determination by light figures. M. YAMAMOTO AND J. WATANABÉ. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 135–46 (*April*, 1953).

The procedure for a perfect, rapid and accurate determination of orientations of trigonal bismuth single crystals by the use of light figures produced by their $\{111\}$ and $\{uu\bar{v}\}$ planes has been developed, the indices of the latter plane being high and somewhat indefinite. Full accounts are given of the geometrical relationships, procedure and etching directions required for the orientation determination, the directly and accurately measurable ranges and kinds of angles, the representation of crystal orientations and the accuracy and actual examples of the orientation determination. It is shown that the perfect determination of crystal orientations can be made with an accuracy within $\pm0{\cdot}2°$ by the use of $\{111\}$ and $\{uu\bar{v}\}$ light figures produced by etching with 50% aqueous solution of 1 : 2 mixture of hydrochloric acid and nitric acid, though bismuth crystals show complex light-figure phenomena, different from cubic crystals and hexagonal zinc crystals and consequently the procedure of orientation determination by the light-figure method becomes somewhat complicated. A.

548.522 : 551.574.1 : 551.578.41

6111. The growth of ice crystals in a supercooled water cloud. B. J. MASON. *Quart. J. Roy. Meteorol. Soc.*, **79**, 104–11 (*Jan.*, 1953).

Equations are derived for the growth rate of ice crystals in the form of thin plates and prismatic columns suspended in a supercooled water cloud given temperature. The effect of the fall motion the crystal on its development is discussed— particular a criterion is derived for the transition fr polyhedral to dendritic growth. Ice crystals gro in supercooled water clouds produced in large c chambers reveal a double change of habit in temperature range 0° to −40°C. Experimen determinations of the growth rates of plate cryst growing at −2·5°C and prisms at −5°C are in fai good agreement with the theory.

548.

6112. Polytypism in SiC crystals. H. JAGODZINS Letter in *Acta cryst.*, **7**, 300 (*March*, 1954).

Of 150 crystals examined by X-rays 62 belonged the one-dimensionally disordered type. The evaluat degrees of disorder in the crystals showed that orc in SiC crystals is stabilized by vibration entropy a that the long-range order commonly observed understandable. Taking the stable structure as cub and vibration entropy as the ordering effect of stac ing faults, the way in which the most probab structures may be derived is briefly indicated.

S. WEINTROU

548.

6113. Polytypism, due to spiral growth, of crystals normal alcohols. S. AMELINCKX. *C.R. Acad. Sc [Paris]* **237**, 1726–8 (*Dec.* 21, 1953) *In French.*

See Abstr. 3981 (1954). The interlaced spir patterns observed on crystals of normal alcohols a reproduced schematically and shown to be derive from simple spirals. The three patterns correspon to three kinds of polytypism. Only the hypothes that the crystals consist of a pile of planes in whic the adjacent growth layers are orientated at angle of 60°, 120° and 180° will account for the patterns.

S. WEINTROU

548.54 : 551.578.4

6114. Dependence of the forms of natural snow crystals on meteorological conditions. L. W. GOLD AN B. A. POWER. *J. Meteorol.*, **11**, 35–42 (*Feb.*, 1954).

Observations were made on the crystal structure o natural snow during a snowfall and related to th meteorological data obtainable for the period o observation. A dependence of crystal type on tem perature, in reasonable agreement with the laboratory results of Nakaya, was observed. Further relations were noted which indicated the readiness with which snow-crystal observations can be related to other meteorological conditions. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 536.631

6115. On the lattice vibrations and the specific heat of a binary alloy with face-centered cubic lattice. Y. FUKUDA. *Sci. Rep. Tôhoku Univ. First Ser.*, **36**, 272–7 (*Dec.*, 1952).

Using the Born–Kármán model, the vibrational

tes of lattice of $AuCu_3$ alloy for the states of any ree of order are calculated. The ν-σ curves for t states of perfect order and of perfect disorder plotted along the three principal directions (100), 0) and (111). The influence of the degree of order the frequency distribution and specific heat of the ice are discussed. A.

548.7

6. On the elastic frequency distribution function simple crystals. S. Huzinaga and T. Hasino. *gr. theor. Phys.*, **10**, 279–95 (*Sept.*, 1953).

A close examination of the characters of the approxitions of Montroll and Houston is presented. It is ommended that these two approximations should used complementarily. The authors adopt the rn–Kármán model and examine mainly a square tice, a simple cubic lattice and a face-centred bic lattice. A.

548.7 : 537.213

17. Mean potential distribution near the crystal rface. Y. Siota. *Sci. Rep. Tôhoku Univ. First Ser.*, , 18–20 (*July*, 1952).

The potential distribution near the crystal surface ving an infinite plane boundary parallel to (100), 10) or (111) plane is calculated as a function of the stance from the surface. Details of calculation are ven for a KCl crystal and the result shows that ean potential distribution near the crystal surface es not depend on the kind of crystal surface. A.

548.7 : 539.185

18. Crystal dynamics and inelastic scattering of utrons. G. Placzek and L. Van Hove. *Phys. ev.*, **93**, 1207–14 (*March* 15, 1954).

A general discussion is given for the angular and nergy distribution of neutrons inelastically scattered y a crystal, with special emphasis on those features of he distribution in which the dynamical properties of he crystal manifest themselves most immediately. he direct relationship between the energy changes in cattering and the dispersion law of the crystal vibraons is analysed. While for X-rays, due to the xtremely small relative size of these energy changes, he dispersion law has to be inferred indirectly from ntensity measurements, it is shown that the very uch larger relative magnitude of energy transfers in he case of slow neutrons opens the possibility of irect determination of the frequency-wave vector elationship and the frequency-distribution function f the crystal vibrations by energy measurements on cattered neutrons. The general properties of the outoing neutron distribution in momentum space which re relevant for this purpose are derived by first conidering the particularly instructive limiting case of eutrons initially at rest and subsequently generalizing he results to incident neutrons of arbitrary energy. A.

548.7

119. Calculation of the moments of the vibrational requency distributions of simple crystals. T. H. Valnut. *J. chem. Phys.*, **22**, 692–4 (*April*, 1954).

A method of obtaining moments of frequency istributions of vibrations of simple crystal lattices is emonstrated. The moments are obtained directly rom corresponding powers of the dynamical matrices n terms of simple displacement co-ordinates. A.

548.7

6120. On the interaction of electrons with lattice vibrations. H. Kanazawa. *Progr. theor. Phys.*, **10**, 275–8 (*Sept.*, 1953).

Uses the intermediate coupling method developed by Lee, Low and Pines. The energy of the system is calculated to the first approximation. The expression for the energy is equivalent to that obtained by Fröhlich. A.

548.7

6121. Electronic structure of BaO crystal. A. Morita and C. Horie. *Sci. Rep. Tôhoku Univ. First Ser.*, **36**, 259–71 (*Dec.*, 1952).

The electronic structure of the BaO crystal is calculated using the cellular method originated by Wigner and Seitz. Results obtained are discussed in comparison with the energy level diagram derived by using the semi-quantitative method which was developed by Seitz and with the tentative energy level diagram proposed by Krumhansel on the basis of several experimental data on BaO. The effective mass of the electron in the conduction band is also discussed. A.

548.7

6122. Calculation of the energy band structures of the diamond and germanium crystals by the method of orthogonalized plane waves. F. Herman. *Phys. Rev.*, **93**, 1214–25 (*March* 15, 1954).

The mathematical procedure employed in recent exploratory calculations of the energy band structures of the diamond and germanium crystals is described. Some of the symmetry properties of the eigensolutions of diamond-type lattices and the construction of an approximate potential for the diamond crystal are reviewed. The relative order of the crystal eigenvalues $E_\gamma(\mathbf{k})$ for a particular $\mathbf{k}$ was found to depend more upon the symmetry of the crystal potential than upon the detailed nature of this potential. On the other hand, the curvatures of the energy surfaces calculated by perturbation theory were found to depend in a rather critical manner upon the exact form of the crystal potential. It would appear that more reliable estimates of the energy band structures of actual crystals can be obtained with the aid of Herring's method of orthogonalized plane waves than by means of other approximational methods requiring comparable effort provided (1) reliable crystal potentials are employed, (2) calculations are carried to the point where the eigensolutions are satisfactorily "convergent," and (3) eigensolutions for more than just the points of high symmetry in the reduced zone are investigated. A more elaborate calculation of the energy band structure of the germanium crystal has been undertaken; the work is now in progress. A.

548.7 : 538.222

Paramagnetic resonance in neutron-irradiated diamond and smoky quartz. *See Abstr.* 5807

548.7

6123. Relation between vacancy energy, surface energy and the elastic constants of crystals. A. Kochendörfer. Note in *Naturwissenschaften*, **41**, *No.* 2, 36 (1954) *In German.*

The energy of a vacancy is estimated as the energy of two Peierls edge dislocations on neighbouring

planes. The results agree well with half the activation energy for self-diffusion. It is also compared with the surface energy of a spherical cavity of one atom diameter and it is found that the effective surface energy to be used is about 0·43 of the observed surface energy for f.c.c. metals. W. M. LOMER

548.7

6124. Regularity of the *F*-center maxima in fused silica and α quartz. A. J. COHEN. Letter in *J. chem. Phys.*, **22**, 570 (*March*, 1954).

548.7

6125. On the formation of colour centres in quartz. E. W. J. MITCHELL AND E. G. S. PAIGE. Note in *Proc. Phys. Soc.* [*London*] *B*, **67**, 262–4 (*March*, 1954).

Absorption bands in crystalline and fused quartz specimens produced by X-rays or by neutrons are compared. Rates of band intensity growth under excitation and bleaching characteristics are measured. G. F. J. GARLICK

548.7

6126. Rate of production of color centers in KCl and KBr by X-rays at 78°K. W. H. DUERIG. *Phys. Rev.*, **94**, 65–70 (*April* 1, 1954).

Growth rates are presented of the F, F', K, V_1, V_2 and V_4 bands occurring when KCl and KBr crystals are X-rayed at 78°K in darkness and under F' light. Under these conditions the concentration of F, F', K and V_1 centres present at any given time of X-ray exposure is found to have two fixed values, dependent only on whether the crystal is in darkness or under F' light. The rates of production of these centres are reproducible if the crystals are warmed to room temperature under white light after each X-raying at 78°K. This reproducibility indicates that the imperfections responsible for these centres at 78°K are fully removed and the crystals are restored to their initial condition before X-raying, at least as far as these colour centres are concerned. A qualitative discussion of the data is presented. A.

548.7 : 538.221

Ferromagnetic domain patterns on nickel crystals. *See Abstr.* 5799

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 6037–45

548.73

6127. The number of X-ray diffraction groups. C. D. WEST. Letter in *J. chem. Phys.*, **22**, 150–1 (*Jan.*, 1954).

It is claimed that the 120 diffraction groups listed by Buerger [*X-ray crystallography* (1942) Table 34] and others, should be increased to 122. A. R. STOKES

548.733

6128. A single-crystal microbeam X-ray goniometer. J. SINGER, J. A. RICHARDS AND W. C. MOXLEY. *Canad. J. Technol.*, **31**, 155–9 (*July–Aug.*, 1953).

A microbeam X-ray diffraction camera has been built for irradiation of selected areas of ~35 μ diameter. The instrument is designed about a horizontal Machlett diffraction tube, but can be used with other, including high intensity, installations. Single crystal oscillation and Laue techniques are provided for, a special centred goniometer head being included. Leaded-glass collimators are used for defining the beam, and location of the latter is achieved with fluorescent crystal and a Geiger counter.

548.7

6129. Microphotometer for the radiographic analysis of crystals. L. CAVALCA. *Ricerca sci.*, **23**, 1586–(*Sept.*, 1953) *In Italian.*

A photometer, similar to that of Bezzi, is described it is very suitable for measuring the diffracted intensities of Weibenga and Smits photographs. It can also be used for measuring the diffracted intensities of single-crystal and Debye photographs. The instrument is very simple to make.

548.7

6130. A precision 19 cm X-ray diffraction camera. J. ADAM. *J. sci. Instrum.*, **31**, 131–2 (*April*, 1954).

A camera free of eccentricity and film mounting errors is described. Sets of knife edges commonly used in 19 cm cameras have been replaced by reference marks. The camera is calibrated by direct measurement.

548.7

6131. Surface layers effective for X-ray reflection. M. SUZUKI. *Sci. Rep. Tôhoku Univ. First Ser.*, 3 137–41 (*Dec.*, 1951).

With a slab of single crystal quartz of 4·60 mm thickness Laue photographs were taken by a narrow parallel X-ray beam, which was made parallel passing through two narrow linear slits. Each spot observed appears as a pair of spots, so that the two surface layers of the crystal reflect X-ray beams more strongly than the interior part of the crystal. By adequate geometrical adjustment of the crystal and the slits, each of the reflections $(1\bar{3}20)$, $(2\bar{5}30)$, $(12\bar{1}$ $(2\bar{3}10)$ and $(3\bar{4}10)$ appeared as a pair of lines parallel to the longer side of the slits. Measurements are made on the intervals of a pair of lines belonging to each reflection. Comparing the measured interval with the real thickness of the crystal, the thickness of the surface layers effective for X-ray reflection is calculated. The mean effective thickness obtained amounts to 0·19 mm for a quartz surface ground by carborundum powder No. 180, and almost the same effective thickness was found for both surfaces. A

548.73

6132. X-ray reflection from twin layer of quartz crystal. M. SUZUKI. *Sci. Rep. Tôhoku Univ. First Ser.*, **36**, 250–5 (*Dec.*, 1952).

Quartz plates a few millimetres thick were cut and formed, so that each contained a twin layer nearly in the middle layer of the plate thickness. Laue patterns were photographed by transmission of a narrow parallel X-ray beam, setting the crystal surfaces nearly perpendicular to the incident beam. A Laue spot reflected from net planes belonging to the zone appears as a triplet of parallel lines. This triplet is generally composed of two strong lines, lying outside the triplet reflected from two crystal surfaces, and a weak line between them. The middle line can be considered as due to reflection from the twin layer. Therefore in the twin layer the crystal lattice is disturbed in some degree and enhances the intensity of X-ray reflection. A

548.735

. The size determination of lattice distortions (...ocations) in powdered materials with various grain ... crystallite sizes. A. KOCHANOVSKÁ. Letter in ...*h. J. Phys.*, **2**, 143–5 (1953) *In Russian.*

... the powder photograph of a crystalline material ... dislocations, the intensity of high-angle lines is ...eased by a factor $C\exp[-2B'(\sin^2\theta)/\lambda]$, where ... $(8/3)\pi^2\bar{u}_1^2$, $\bar{u}_1^2$ being the mean-square displace... ...t of atoms from their normal positions. $\bar{u}_1^2$ can ...ound by comparing the ratios of the integrated ...nsities of a pair of lines with different θ angles for ...ocated and non-dislocated specimens. If the ... r is not available an estimate of $\bar{u}_1^2$ can still be ...ined from a single specimen from

$$3\log\left(\frac{I_{h_1k_1l_1}}{I_{h_2k_2l_2}}\times\frac{Q_{h_2k_2l_2}}{Q_{h_1k_1l_1}}\right)\div\left(16\pi^2\frac{\sin^2\theta_2-\sin^2\theta_1}{\lambda^2}\right)$$

...re I is the observed integrated intensity and Q is ...calculated specific reflecting power (including the ...perature factor). A. L. MACKAY

548.735

4. The analysis of quantitative pole-figure data. ...G. DUNN. *J. appl. Phys.*, **25**, 233–6 (*Feb.*, 1954). ...n analysis of isolated concentrations of poles in a ...e-figure plot has been made in terms of a normal ...ariate frequency distribution. A definition of pole ...sity is given, and absolute units for measuring pole ...sity are introduced. Simple procedures for deter...ning the standard deviation of the pole-density ...ribution and for calculating the fraction of ...stals in one preferred orientation in a texture con...ing of several preferred orientations are given. A ...thod of constructing a quantitative pole figure ...m a number of single Laue patterns and crystal ...s in coarse-grained material also is given. A.

548.735 : 518.4

...5. A graphical method of evaluating trigonometric ...ctions used in crystal structure analysis. I–II. H. J. ...ENVILLE-WELLS. *J. appl. Phys.*, **25**, 485–90 (*April*, ...54).

A graphical method is described for evaluating struc...e factors of the form

$$F(hk0)=\sum_0^n f_r(hk0)\begin{matrix}\sin\\ \cos\end{matrix}2\pi(hx_r+ky_r)$$

...d electron density expressions of the form ...$X,Y)=\Sigma\Sigma F(hk0)\begin{matrix}\sin\\ \cos\end{matrix}2\pi(hX+kY)$. The method ...pends upon the fact that if, in a [001] projection of ...nit cell the normal to the planes $(hk0)$ is graduated ...th the appropriate sine or cosine function giving ...e phases of points along the normal, then a circle ...th its centre at $(\frac{1}{2}x, \frac{1}{2}y)$, passing through the origin, ...ll cut the normal to $F(hk0)$ at the value of ...$2\pi(hx+ky)$. ' Pt I contains the basic principles ...d a standard chart, and Pt II cites examples of the ...e of the method and the accuracy to be expected in ...ucture factor calculations, and of its application to ...ast-squares refinements. A.

548.735.4

36. Calculation of structure factors by means of modification of Eller's optical machine. L. BRÚ, M. PÉREZ R. AND A. L. CASTRO. *An. Real. Soc. Españ. Fis. Quím*, **49(A)**, 311–14 (*Nov.–Dec.*, 1953) *In Spanish.*

It is shown that the addition of a new mask makes it very easy to obtain the values and signs of structure factors. The method is applied to the structure of hexamethylenediame dihydrobromide. A.

548.735.44

6137. Adaptation of the superposition method. A. LÍNEK. Letter in *Czech. J. Phys.*, **2**, 145–6 (1953).

A supplementary note to a previous paper [Abstr. 5149 (1954)] dealing with a superposition method for the approximate determination of crystal structure. The method is based on a type of difference synthesis. J. THEWLIS

548.735.7

6138. X-ray studies on the texture of crystals. A new method using internal reflections and its applications to lithium fluoride. V. M. PADMANABHAN. *J. Indian Inst. Sci. A*, **35**, 1–8 (*Jan.*, 1953).

The method consists in obtaining internal reflection from a wedge-shaped crystal, whose thickness varies from top to bottom, and determining the variation of integrated reflection with thickness which was shown theoretically by Ramachandran to be different for perfect and mosaic crystals. Experiments were performed with ground, etched and chilled crystals of lithium fluoride and observations were found to be in accordance with the theoretical predictions. Crystals of lithium fluoride, grown from melt, were thus found to be nearly perfect in structure. A.

548.736.3

6139. The intermetallic phase $NpBe_{13}$. O. J. C. RUNNALLS. Letter in *Acta cryst.*, **7**, 222–3 (*Feb.*, 1954).

This is the only intermediate phase between α Np and Be at room temperature. It is face-centred cubic with lattice constant 10·256 at low to 10·266 Å at high Be content, indicating some small range of solubility. The unexpected contraction on the Np rich side (Np atom $\sim$ 35% larger than Be atom) may be due to formation of a Be deficient defect structure. A. D. LE CLAIRE

548.736.3

6140. Experimental study of the variation of the degree of order with temperature in a copper–palladium alloy. D. M. JONES AND E. A. OWEN. *Proc. Phys. Soc.* [*London*] *B*, **67**, 297–303 (*April*, 1954).

Gives an account of an X-ray study of the copper-palladium alloy Cu_3Pd, with special reference to the variation of the degree of order with temperature as revealed by the degree of tetragonality of the structure at different temperatures. From the relation between the axial ratio of the structure and the temperature it is concluded that the transformation from the cubic face-centred structure to the tetragonal face-centred structure takes place at 460°c and the material is fully ordered at temperatures below about 270°c when the axial ratio c/a is 0·9851 and the a-parameter 3·7021 kX at 18°c. On the assumption that the degree of tetragonality gives a measure of the degree of order it is concluded that the relation between the axial ratio and the degree of order is given by $c/a = 1-0{\cdot}015W$ when W is the degree of order. A.

548.736.3 : 538.22

Structural changes in hexagonal manganese compounds. *See Abstr.* 5793

548.736.3 : 539.133

6141. The crystal and molecular structure of B_5H_{11}. L. R. LAVINE AND W. N. LIPSCOMB. *J. chem. Phys.*, **22,** 614–20 (*April*, 1954).

The molecular structure of B_5H_{11} has been determined from 299 X-ray diffraction maxima which have been analysed by three-dimensional Fourier and least-squares methods. There are four molecules in a monoclinic unit cell, in the space group $P2_1/n$, having parameters $a = 6{\cdot}76$, $b = 8{\cdot}51$, $c = 10{\cdot}14$ Å, and $\beta = 94{\cdot}3°$. Although no molecular symmetry is demanded by the space group, the molecular dimensions indicate C_s symmetry for the isolated molecule. The boron skeleton is a fragment of the icosahedron-like arrangement in $B_{10}H_{14}$, and can also be derived from the tetragonal pyramid in B_5H_9 by opening up one of the basal B–B bonds. The apex boron B_I is "singly" bonded to two hydrogens, one of which H_{VII}, is very weakly bonded to the two outer borons B_{III}. Each B_{III} is "singly" bonded to two hydrogen atoms. Each of the remaining two borons B_{II} is "singly bonded" to one hydrogen atom, and there are three bridge hydrogens, one bridging the B_{II}–B_{II} bond and two bridging the B_{II}–B_{III} bonds. Molecular parameters are two B_I–$B_{III} = 1{\cdot}86_5$, two B_{II}–$B_{III} = 1{\cdot}75$, two B_I–$B_{II} = 1{\cdot}72$, one B_{II}–$B_{II} = 1{\cdot}77$ Å, seven B–H $= 1{\cdot}0_7$, six B–H (bridge) $= 1{\cdot}2_4$ Å, one B_I–$H_{VII} = 1{\cdot}0_0$ and two B_{III}–$H_{VII} = 1{\cdot}6_7$ Å. The B_{III}–B_I–B_{III} angle is 107°. Bond angles to hydrogen strongly resemble those in the other known boron hydrides. A.

548.737

6142. The crystal structure of acetylene. I. T. SUGAWARA AND E. KANDA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4,** 607–14 (*Dec.*, 1952).

The crystal structure and phase transition of acetylene were studied by means of a low-temperature X-ray single crystal technique. The crystal showed a lattice transformation at about −140°C. The high-temperature modification was cubic with four molecules in a cell of the dimension $a = 6{\cdot}14$ Å at −117°C, the space group being T_h^6–$Pa3$. The parameters of carbon and hydrogen atoms were determined by the Fourier method. The molecular dimensions derived from the parameters were C ≡ C = 1·20 Å and C–H = 1·05 Å, the molecule being linear. The closest approach between neighbouring molecules were H...H = 3·28 Å and C...C = 3·89 Å. Preliminary results of the low-temperature structure based on powder photographs are also described. A.

548

6143. A structure for collagen. F. H. C. CR
Letter in *J. chem. Phys.*, **22,** 347–8 (*Feb.*, 1954).

Atomic coordinates are given for a proposed mo
in which two polypeptide chains are wound helic
round a common axis. It is stated that this struct
appears to be in qualitative agreement with the X-
data. A. R. STC

548

6144. Electron diffraction by single crystals.
RICHTER AND H. KNÖDLER. *Z. Naturforsch.*,
147–64 (*Feb.*, 1954) *In German.*

When rolled metal foils were suitably etched
heat-treated single crystal electron diffraction pho
graphs could be obtained from them. Similar pho
graphs could also be obtained from suitably hea
electrodeposited layers. Such photographs w
indexed by a method involving a knowledge of
crystal structure but not of the crystal orientation
which the diffraction spots are first assigned arbitr
indices on the assumption that they represent a t
dimensional (*hk*) reciprocal-lattice. This is relate
the true three-dimensional lattice by projection a
the method permits this relationship, and hence
orientation of the crystals, to be determined. Seve
examples are given and other features of the pho
graphs are discussed. J. THEW

548.74 : 537.22

**6145. Neutron diffraction study of the ferroelect
modification of potassium dihydrogen phospha**
H. A. LEVY, S. W. PETERSON AND S. H. SIMONS
Letter in *Phys. Rev.*, **93,** 1120 (*March* 1, 1954).

The [*hhl*] zone of a cylindrical specimen w
examined at 113°K, using a neutron wavelength
1·062 Å at values of sin θ/λ up to 0·77. A Four
synthesis method was employed, allowance bei
made for errors due to termination of series. T
results show that the arrangement of the H atoms
ordered. J. THEW

548.74 : 537.226

**6146. Ferroelectric structure of potassium dihyd
gen phosphate.** R. S. PEASE AND G. E. BACO
Letter in *Nature* [*London*] **173,** 443–4 (*March* 6, 195

Fourier synthesis of single-crystal neutron diffra
tion data gives a projection of scattering density
(001) which shows the hydrogen atoms to be d
placed 0·21 Å from the centre of the 2·49 Å O—H—
bonds, in an ordered array satisfying F_{dd} symmetr
Reversing the applied electric field reverses the dire
tion of the displacements. Slater's [*J. chem. Phys.*,
16–33 (*Jan.*, 1941)] hypothesis of the origin of t
dielectric properties is thus shown to be correct.
R. S. PEA

GEOPHYSICS 55

550.342 : 534.22

6147. New method for measuring wave velocities in stone. E. MÜLLER. Note in *Naturwissenschaften*, **41,** *No.* 4, 85 (1954) *In German.*

A brief reference is made to a method for measuring the longitudinal and transverse wave velocities in stone specimens about 3 cm long and a few mm thic
by taking spark photographs of the motion of th
waves set up in a fluid in which the stone is immerse
The velocities and elastic constants of 10 commo
stones are given; the values agree with those found i
seismic practice. The method is to be described full
in another publication. H. J. H. STARK

550.361

Temperature distribution within the earth's J. A. JACOBS; R. J. UFFEN AND A. D. MISENER. rs in *Nature* [*London*] **173,** 258–9; 259–60 6, 1954).

ing Simon's recent results for the melting point on at high pressures [Abstr. 906 (1954)], Jacobs computed a probable value of temperature at of solid mantle, depth 3000 km, to be 3600°K, an upper limit of 4000°K. Corresponding values outed by Uffen and Misener from the same data 000° K and 5000°K. D. R. BARBER

550.372 : 621.3.011.22 : 621.316.993

. A study of d.c. resistivity of Calcutta soil. BHATTACHARYYA AND P. C. MAHANTI. *Indian J.* ., **27,** 615–27 (*Dec.*, 1953).

eports the d.c. resistivity of soil in and around city of Calcutta and of its variation with time, perature and humidity. The effect of endosmosis also been ascertained. A.

550.38 : 538.082

hree-component aeromagnetometer. *See Abstr.* 7

550.384 : 551.510.535 : 523.75

) Ionospheric and geomagnetic effects of solar s. J. W. BEAGLEY. *New Zealand J. Sci. Technol.* 5, 141–51 (*Sept.*, 1953).

eomagnetic crochets occurring at Amberley and a during the years 1947 to 1951, simultaneous with r flares and Dellinger fadeouts, have been con- red in relation to following magnetic and iono- eric disturbances. Their hourly and seasonal quencies have been examined and their augmenta- n of the normal diurnal inequality verified. Par- lar reference has been made also to solar flares, chets, and fadeouts during February 1950 and the owing disturbances. A.

550.385

1. Very long sequences of geomagnetic activity its annual variation. B. N. BHARGAVA AND M. NAQVI. Letter in *Nature* [*London*] **173,** 498–9 *arch* 13, 1954).

Extraction of 3-day running means of international gnetic character figures *C* shows sequences of gnetic activity lasting much longer than thought herto. Activity decreases after 5–6 recurrences d then becomes appreciable again. One sequence starting July 11–12, 1950, still showed on Sept. 19, 53, and another (*B*) starting Nov. 11, 1951, still owed on Sept. 3, 1953. (*A*) has maximum activity ce yearly, Sept.–Oct., and a minimum March– ril. For (*B*) the dates are exactly reversed. It is ncluded that (1) two principal long-lived *M*-regions st, separated by about 130° longitude and account- for the two separate long series of magnetic rms, (2) the single yearly maximum for each series dicates that the *M*-regions were located at helio- aphic latitudes $> 7 \cdot 2°$, (3) the characteristic nual variation of geomagnetic activity, associated h the solar *M*-regions considered is due to the proach of the earth's projection on the solar disk vards the zones of maximum solar activity.

R. S. READ

550.837.6 : 538.52

Fields of a line source of current over a stratified earth. *See Abstr.* 5811

550.837.6 : 538.52

Induction by horizontal oscillating magnetic dipole over a conducting homogeneous earth. *See Abstr.* 5812

550.839

6152. Summary of A.E.R.E. (Harwell) equipment for use in prospecting and assaying radioactive ores. *Atomic Energy Res. Establ.* [*Harwell*] *Mem. EL/M* 83, 10 *pp.* (1953).

Equipment described includes portable ratemeters, borehole logging equipment, transportable (car or airborne) radioactivity detecting equipment and laboratory assay equipment. A brief description of the various instruments is given and some indication of the applications. J. M. HOUGH

550.93

6153. Carbon-13 variations in sequoia rings and the atmosphere. H. CRAIG. *Science,* **119,** 141–3 (*Jan.* 29, 1954).

Isotopic analyses have been made from the wood of individual rings in the same specimen for various years during the period 1072 B.C. to A.D. 1649. The results show that the atmospheric carbon isotopic composition was constant to at least 1 per 1000 with a change in mean composition of probably less than $0 \cdot 2$ per 1000. It is thought more likely that this change is due to effects of varying external conditions on assimilation rather than to atmospheric changes and there appears to be some evidence of a change in the isotope composition during the early period of the tree's history. J. M. HOUGH

551.35.054.2

6154. Size of fragments resulting from tidal disintegration. P. S. PALMER. Letter in *Nature* [*London*] **173,** 499 (*March* 13, 1954).

Contrary to the suggestion made by Jeffreys (1947) that, under the action of primary tidal stresses, the size of rock or ice fragments would be > 200 km, it is shown how a combination of primary and secondary compressional, shear and tensile stresses may bring about disintegration into fragments of size ranging from ~ 1 km down to that of sand-particles.

D. R. BARBER

ATMOSPHERE . METEOROLOGY 551.5

551.508

6155. An oscillating psychrometer for micrometeorological purposes. C. T. DE WITT. *Appl. sci. Res. A,* **4,** *No.* 2, 120–6 (1953).

A psychrometer is described which is adequately ventilated by oscillating the dry and wet thermocouples with an amplitude of about $1 \cdot 5$ cm and a frequency of ~ 40 c/s. The temperature and humidity profile is destroyed to a far less extent with this meter than with psychrometers ventilated in the ordinary way. It has been shown that the true vapour

pressure of the air is measured by means of an irradiated psychrometer if the dimensions and the reflection coefficients of the dry and wet bulbs are the same. A.

551.508.765

6156. A photoelectric raindrop spectrometer. B. J. MASON AND R. RAMANADHAM. *Quart. J. Roy. Meteorol. Soc.*, **79**, 490–5 (*Oct.*, 1953).

An instrument which gives a continuous, automatic record of the size distribution of raindrops at ground level is described. The light scattered by the drops in falling through an optically defined area of a light beam is focused on to a photomultiplier cell and the resulting voltage pulses are sorted electronically into eight different size groups. The spectrometer is used to study the variation of the drop-size spectrum with time and with the rate of rainfall. Calibration curves and some specimen results are presented. A.

551.510.41

6157. The natural tritium content of atmospheric hydrogen. A. V. GROSSE, A. D. KIRSHENBAUM, J. L. KULP AND W. S. BROECKER. Letter in *Phys. Rev.*, **93**, 250–1 (*Jan.* 1, 1954).

A more accurate measurement than that of Faltings and Harteck [Abstr. 761 (1951)] using water prepared from the hydrogen component of an air liquefier. This was in some cases electrolytically enriched but in all cases it was reconverted to hydrogen and measured in a Geiger counter. The mean figure obtained was $1{\cdot}54\times10^{-14}$, or $1{\cdot}66\times10^{-14}$ after correction for decay, as the ratio of tritium to normal hydrogen with an accuracy of better than 10%. J. M. HOUGH

551.510.41 : 539.155.2

6158. The abundance of O^{18} in atmospheric water and water vapour. W. DANSGAARD. *Tellus*, **5**, 461–9 (*Nov.*, 1953).

Investigations into the O^{18} abundance in the precipitation from a warm front reveal a distinct process of fractionation explainable by the unequal pressures of the saturated vapours of H_2O^{16} and H_2O^{18}. An explanation is given of the low O^{18} abundance in glacial waters. A method of experimental investigation into the mechanism of the process of precipitation is discussed. A.

551.510.535

6159. Global characteristics of the separation between the F_1 and F_2-layers of the ionosphere. M. GHOSH. *Indian J. Phys.*, **27**, 421–30 (*Aug.*, 1953).

Records of a number of ionospheric stations in north and south latitudes have been analysed to study the global characteristics of the seasonal and solar cycle variations of the separation between the F_1 and F_2 layers of the ionosphere. So far as the seasonal variation characteristics are concerned, they are found to be similar to those observed by Appleton for the height variation of the F_2-region. The variation of the separation with the sunspot activity shows the following unexpected features: At high latitude stations the separation follows the trend of sunspot activity in local summer. In local winter, however, in such latitudes, there is no association between the two. At stations close to the geomagnetic equator, the separation is related to sunspot activity in an inverse manner in all the seasons. At stations of low i mediate latitudes, no appreciable correlation between variation of sunspot activity and the varia characteristics of the F_1–F_2 separation in any sea (The separations all refer to the mean noon val The seasonal and latitudinal variations can be plained (if the effect of tidal forces are taken account) on the basis of the current hypothesis o composite F-region formation, namely, that th and F_2 regions belong to a common bank of ioniza and two maxima are produced in this common due to the peculiar physical characteristics of atmosphere in this region. Regarding the varia characteristics of the separation with sunspot act no simple explanation is possible with the pre state of knowledge.

551.510

6160. On the law of the variation of E-region m mum with the zenith distance of the sun. A. K. S. *Indian J. Phys.*, **27**, 431–8 (*Sept.*, 1953).

The diurnal records of E-layer critical frequ ($f^\circ E$) at Calcutta for the years 1949–52 are anal to determine the value of n in Chapman's for $f^\circ E = f_s(\cos\chi)^n$. n is found to vary from 0·1 0·50 instead of remaining constant at the Chap value of 0·25. The sub-solar frequency f_s undergoes similar variations. There appears to seasonal component of n and f_s variations whic most marked in the years 1950 and 1951. The m trend of these variations follows that of the 12-mo running average Zürich sunspot number. The res obtained are discussed in relation to those obtai by previous workers. The departures from Chapman law may be attributed to changes in height distribution of O_2 in the transition region (wh the atmospheric composition changes from one of and N_2 to one of O and N_2) where the E-regio formed by the ionization of O_2. Detailed study of variations of n and f_s will be helpful in the accu prediction of E-region transmission conditions.

551.510.

6161. Motion of a single cloud in the ionosphe S. N. MITRA. *Indian J. Phys.*, **27**, 562–4 (*Nov.*, 195

The fading on pulsed transmission is known to due to interference between waves scattered fr local irregularities in the ionosphere, the irregulari having both random and steady motion. The nat of the fading pattern indicates that a large number irregularities is involved in the process. But, und favourable conditions, it is possible to detect a sin cloud in the ionosphere, the fading of the receiv signal being caused by its bodily motion with existing wind velocity.

551.510.5

6162. Horizontal movements in the ionosphe B. H. BRIGGS AND M. SPENCER. *Rep. Progr. Phys.*, 245–80 (1954).

The object of the paper is to survey the existi knowledge of horizontal movements in the ionosphe as obtained by radio methods. After a brief intr duction the various methods and associated resu are described under the following main heading Reflected radio waves observed at closely spac points; Observations of movements of large-sca

ılarities in the *F* region; Observations of waves radio stars; Observations of waves reflected meteor trails; Observations of waves reflected the sporadic-*E* layer. The most detailed discus- is accorded to the first of these methods, with n the authors have been personally associated. results obtained at Cambridge, England, by this od are compared with the results obtained by workers using this and the other methods in ent parts of the world. The following con- ons are reached: At all levels in the ionosphere matic as well as irregular horizontal movements present. Typical velocities are of the order of /sec; there is a tendency for the velocity to in- se with height. The systematic movements have form of regular diurnal and seasonal variations show considerable consistency between observa- s made in the northern and southern hemispheres. heights around 100 km the semi-diurnal com- ents of the velocity, as determined by Fourier ysis, are found to represent a uniformly rotating city vector; the direction of the rotation is clock- in the northern hemisphere and anti-clockwise the southern hemisphere. This is the type of vement predicted by the theory of atmospheric llations, though the phase of the rotation is not expected theoretically. At times of magnetic urbance the velocities of the horizontal movements increased, and this phenomenon becomes more ked with increasing height in the atmosphere. At km velocities as high as 1000 m/sec have been rded during magnetic storms. The report ends h a brief summary of observations by non-radio thods. A.

551.510.535

3. Regularities in the *F*-region of the ionosphere. CHATTERJEE. Letter in *Nature* [*London*] **173,** 263–4 *b* 6, 1954).

t is shown that the monthly mean values of the hour average total ion content of the *F*1 and *F*2 ions as a whole exhibits a seasonal variation which sely follows the Chapman $\cos^{\frac{1}{2}}\chi$ law (χ = noon ith angle of sun), and a latitudinal variation which symmetrical about the geomagnetic equator but es not show the "bite-out" (as does f_0F2).

G. M. BROWN

551.510.535

54. A table of Chapman's grazing incidence in- gral Ch(x, χ). M. V. WILKES. *Proc. Phys. Soc. ondon*] *B*, **67,** 304–8 (*April*, 1954).

The paper contains a table of Chapman's function

$$\mathrm{h}(x,\chi) = x\sin\chi\int_0^{\chi}\exp(x - x\sin\chi/\sin\lambda)\mathrm{cosec}^2\lambda d\lambda$$

three decimal places for x = 50 (50) 500 (100) 1000 d $\chi = 20°$ (1°) 100° excluding values of Ch(x, χ) eater than 100. A.

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See* str. 5822–4

551.515.2 : 525.62

Tidal forces and the formation of hurricanes. *See* str. 5248

551.521

6165. Spectrophotometry of radiation from sun and sky. E. R. COOPER AND M. C. PROBINE. *Trans Illum. Engng Soc.*, **19,** *No.* 1, 8–20 (1954).

A spectrophotometer is described by means of which the spectral distribution of radiation from the sun and sky, or the sky alone, may be conveniently measured if the sky is either completely clear or completely overcast. The instrument is calibrated using a standard lamp, whose spectral energy distribution is known in the region 0·4 micron to 0·7 micron. A "fatigue-correcting" lamp, included in the optical system, enables the results to be expressed in energy units. Possible errors are discussed. A.

551.521

6166. Spectral distribution of radiation from sun and sky. J. N. HULL. *Trans Illum. Engng Soc.*, **19,** *No.* 1, 21–8 (1954).

Measurements of the spectral distribution of the radiation falling on a horizontal plane from sun and sky have been made in various kinds of weather, using the spectrophotometer described in the preceding abstract. On overcast days the relative-energy/wavelength curve of sun and sky together is nearly the same as on clear days, although the amount of radiation is only about one-fifth. Haze, thin cloud, and mist produce more noticeable changes in distribution. On clear days small amounts of cloud cause large changes in the distribution of radiation from the sky alone. As an example of a simpler method of stating the distribution, which may be suitable where relative-energy/wavelength curves are unnecessarily detailed, the C.I.E. chromaticity co-ordinates and colour temperatures have been calculated for a few days. A.

551.521 : 536.3

6167. Energy transfer by infrared bands. L. D. KAPLAN. *J. Meteorol.*, **11,** 16–19 (*Feb.*, 1954).

The energy transfer between air layers, and that between an air layer and black surface, are examined for a schematic rotation-vibration band of a gas whose mixing ratio decreases with height. It is found, in general, that most transfer is due to the central portions of moderately weak lines. Small errors in transmission functions may lead to large errors in energy transfer, especially in the upper half of the atmosphere. This is particularly true of the "black line-centre" approximation. A.

551.521.3 : 535.345

6168. Regions of validity of various absorption-coefficient approximations. L. D. KAPLAN. *J. Meteorol.*, **10,** 100–4 (*April*, 1953).

Elsasser's integral for the absorption by a periodic line pattern is evaluated and used to examine the validity of various approximations concerning the absorption coefficient. It is found that composite absorption curves, obtained by ignoring overlapping for small optical paths and ignoring the pressure-dependent term in the denominator of the expression for the absorption coefficient for large optical paths, may be applicable to calculation of radiative heat transfer in the atmosphere. It is shown that the theoretical prediction of the "square-root law" of absorption is based on use of approximations that are particularly invalid for the cases for which the "law"

is supposed to be valid. An explanation is given for the apparent experimental verification of this "law." A.

551.521.3 : 535.345

6169. Spectral line shape and its effect on atmospheric transmissions. A. R. CURTIS AND R. M. GOODY. *Quart. J. Roy. Meteorol. Soc.*, **80**, 58–67 (*Jan.*, 1954).

The detailed shape of a pressure-broadened spectral line obtained by Lindholm has been evaluated and used to derive an expression for the mean transmission of a disordered band. This is compared with the corresponding expression using the Lorentz line shape. It is shown that the difference in mean transmission for these two line shapes is scarcely detectable spectrophotometrically in the cases of the principal telluric bands of ozone and water vapour, and probably also for carbon dioxide. It is concluded that, until more important problems have been solved, it is probably uneconomical to make use of line shapes any more complicated than that of Lorentz for computations of heating rates in the atmosphere, provided always that theory is used only in order to apply existing laboratory data to atmospheric conditions. A.

551.557 : 523.5 : 621.396.969

6170. Measurements of winds in the upper atmosphere by means of drifting meteor trails. I. D. S. ROBERTSON, D. T. LIDDY AND W. G. ELFORD; **II.** W. G. ELFORD AND D. S. ROBERTSON. *J. atmos. terrest. Phys.*, **4**, 255–70, 271–84 (*Dec.*, 1953).

A continuously recording Doppler-radar system operating on 27 Mc/s is described and some typical records are analysed. An accompanying paper deals with the experimental results. A.

551.558.1

6171. Bubble theory of penetrative convection. R. S. SCORER AND F. H. LUDLAM; J. S. MALKUS. *Quart. J. Roy. Meteorol. Soc.*, **79**, 94–103 (*Jan.*); 288–92 (*April*, 1953).

The process of convection is described in terms of a unit or proton of convection—the bubble. A rising bubble of warm air sheds its outer skin steadily into a disturbed wake until it becomes exhausted completely or spreads out at a stable layer. The wake is a region where the ascent of further bubbles is favoured. The wakes of small bubbles close to the ground are aggregated into larger bubbles, which are more dilute, up to a level where they begin to penetrate hitherto undisturbed air, and then they waste away as they ascend further. The air above a bubble is lifted (and cooled) as the bubble approaches and then drains down the outside, the air close to the bubble being mixed into the wake. The wake of a clear bubble is buoyant but that of a cloudy bubble may sink if it is sufficiently chilled by dilution with surrounding clear air. The drag on a bubble is estimated from observations on rising cumulus towers, and a linear relation between buoyancy and limiting velocity is proposed. From this the horizontal velocity of the bubble relative to the surrounding air is deduced to be about the same as the vertical velocity when it ascends through strong shear. A bubble is a compact stable configuration for a rising element. Near the ground the heat is transported by small bubbles, which are less efficient, and therefore require a greater lapse rate, than the larger ones which can operate higher up. The process of aggregation is again renewed within large clou that the bubbles found at the top may be more c than if they had ascended directly from the Clouds growing in a shearing current will grow the shear. Malkus comments critically, and authors reply.

551.

6172. On the formation of germs of condens and solidification round a solid insoluble nucleus DUFOUR AND R. DEFAY. *Tellus*, **5**, 293–301 (1953) *In French.*

Solid insoluble nuclei help the formation of v or ice inasmuch as the adhesion-coefficient of v or ice on the solid be positive. If this coefficie greater than 1 and if the solid nucleus is large en this effect may be sufficient to render null the energy of formation of germs and to provoke condensation or the solidification without g These effects can be calculated *a priori*, assum certain degree of saturation of the atmospheric v vapour provided the suitable adhesion-coefficien known.

551.574.1 : 536.

6173. Homogeneous nucleation of supercooled w drops. J. E. MCDONALD. *J. Meteorol.*, **10**, 41 (*Dec.*, 1953).

The experimentally observed crystallizatio supercooled water near −40°C is examined in term the theory of homogeneous nucleation. The ther dynamic and molecular-kinetic nature of the nu tion process is outlined to show why supercoolin natural clouds can occur so frequently. Past eff to explain the −40°C transition are examined cr ally, and are found to contain a number of signifi errors. Because the theoretical nucleation rates extremely sensitive to the numerical value of specific surface free energy of a water-ice interf particular attention is devoted to the refinement previous estimates of this parameter. It is shown both Krastanow's and Mason's estimates were accurate, and that in the latter's approach, neglec the distortion energy of the surface layer of ice to a marked underestimate of the nucleation efficie which was concealed by the effects of several coun acting errors. Difficulties lying in the way of a di calculation of the distortion energy for ice examined and found to be very serious. A cr correction for distortion effects leads to a theoretic predicted temperature of −26°C for the threshold spontaneous nucleation of drops of cloud-particle s It is concluded that although this result lies well ab the experimentally observed range of transition t peratures, it is close enough to that range (consider the inherent difficulty of assessing the effect of tortion), to strengthen the belief that the −4 transition is due to homogeneous nucleation.

551.574.1 : 551.578.41 : 548.

The growth of ice crystals in a supercooled wa cloud. *See Abstr.* 6111

551.574.1 : 551.59

6174. Condensation nuclei and the development radiation fog. A. C. BEST. *Quart. J. Roy. Meteo Soc.*, **79**, 112–20 (*Jan.*, 1953).

The growth of liquid-water droplets upon c densation nuclei as the relative humidity rises fr

to 100% is examined. It is assumed that the ensation nuclei consist of sea-salt particles and he droplets are always in instantaneous equili- with the ambient relative humidity. An arbi- nucleus-size distribution formula, which is easily ted to fit an intuitively reasonable size distribu- is also assumed. It is found that the shape of ucleus-size distribution curve has very little effect the computed value of the liquid-water content the fog though at saturation W varies as the e root of the mean mass of the nuclei. In near- ation conditions a small variation in relative dity has a big effect upon W. A formula for -size distribution in fog at saturation is developed found to agree with measurements. Visibility e developing fog is briefly considered and it is n that Koschmieder's formula, applied to the ing water drops, leads to results consistent with rience. Neither the mean nucleus mass nor the e of the nucleus-size distribution curve affect the ility at saturation. A.

551.577 : 539.155.2

e natural distribution of tritium. *See Abstr.* 5885

551.593.5

5. Observation of non-Rayleigh scattering in the trum of the day sky in the region 0·56 to 2·2 ons. R. ANTHONY. *J. Meteorol.*, **10**, 60–3 (*Feb.*, 3).

pectral records of the day skylight from 0·56 to μ were obtained at 5415- and 2200-ft stations for morning sun along the solar almucantar with a l-sulphide cell and glass-prism spectrometer. ttering intensities in the spectral region 1·0 to μ appear unusually large up to 30° from the sun. nparison of the recorded scattered intensity with ct solar radiation shows the trend from the high ared scatter toward Rayleigh scattering. A ilar result is obtained by examining the records of el. Examination of the scattering function for cted wavelengths shows the loss of visible light in forward direction and predominance of infrared. mparison with Hulburt's curve for the total visible ion shows similarity only from 90° to 180° from the . The slope of the scattering function at small les for different wavelengths is used as an approxi- te method for obtaining particle size. Values of ghly 0·5 μ for the visible region and 3·5 μ for the rared region have been estimated. The latter re appears unusually large. A.

551.593.9

6. Origin of the emission of the oxygen green e in the airglow. M. NICOLET. Letter in *Phys. v.*, **93**, 633 (*Feb.* 1, 1954).

t is shown that dissociative recombination of mole- ar O_2^+ constitutes the most likely excitation process the emission of the 5577 Å forbidden line in ospheric region *F*. At this emission level (250 km), concentration is still $\sim 5\times10^6$ cm^{-3} and recom- ation takes place in 2 stages, viz. $O^+ + O_2 \rightarrow O +$, and later $O_2^+ + e \rightarrow O' + O''$. The computed tical distribution of 5577 Å emission yields a peak ue at 50–100 km below *F*-region max. electron nsity, i.e. at 250 ± 25 km, thus agreeing with servation. D. R. BARBER

551.594

6177. Reviews of modern meteorology—8. Atmospheric electricity; some recent trends and problems. T. W. WORMELL. *Quart. J. Roy. Meteorol. Soc.*, **79**, 3–38 (*Jan.*, 1953).

551.594.11

6178. On the changes in the atmospheric electric field on meteorologically quiet days. M. KAWANO. *J. Geomagn. Geoelect.*, **5**, 14–21 (*June*, 1953).

Routine observations of the atmospheric electric field, atmospheric electric conductivity and space charge were carried out from August, 1948, to April, 1950, at Hongo, Tokyo. The electric disturbances on meteorologically quiet days are divided into seven cases, and the correlation coefficients between these electric quantities in individual cases are obtained. When $\partial E/\partial t < 4\pi\lambda E$, E bears a simple relation to conductivity λ, space charge ρ and vertical wind velocity $\bar{w}$ near the ground, namely, $\lambda E + \overline{\rho w} =$ const. A.

551.594.13

6179. On the electrical conductivity of the lower stratosphere. J. E. MCDONALD. *Trans Amer. Geophys. Un.*, **34**, 529–33 (*Aug.*, 1953).

The reality of the decrease of conductivity with height observed at the top of the *Explorer II* flight is supported by some measurements made earlier by Idrac. The cause of this decrease is discussed and an hypothesis of convective updraft of Aitken nuclei from troposphere to stratosphere is examined. The hypothesis appears incapable of accounting for a steady-state worldwide population of stratospheric nuclei sufficient to satisfy existing observations. A.

551.594.21

6180. Raindrop charge and electric field in active thunderstorms. R. GUNN AND C. DEVIN, JR. *J. Meteorol.*, **10**, 279–84 (*Aug.*, 1953).

The electrical characteristics of two active spring thunderstorms are reported. Simultaneous surface measurements of the sign and magnitude of the free charge on individual raindrops, the electric field and precipitation rate have been made. More than 7000 drops, representing a continuous sample of the drops falling in the storms, show no important systematic dependence on the sign or magnitude of the instantaneous electric field. The measurements show that the convected current to the earth frequently exceeds the conduction currents by a large factor, and, therefore, the charged rain may determine the electric field at the surface. The average measured free charge brought down by positively charged rain was 0·022 e.s.u., and by negatively charged rain was 0·031 e.s.u. per drop. The ratio of the negative free charge to the positive free charge brought down by rain was 1·2, while the ratio of the number of negative drops to the number of positive drops was 0·88. A.

551.594.21

6181. On the generation of charge associated with graupel formation in thunderstorms. B. J. MASON. *Quart. J. Roy. Meteorol. Soc.*, **79**, 501–9 (*Oct.*, 1953).

It is argued that the generation and separation of electric charge above the 0°C level in thunderclouds are consequences of the growth and fall-motion of

graupel pellets. The results of laboratory experiments which show the acquisition of a negative charge by a growing rime deposit are used to calculate the charge liberated during the growth, in a thunderstorm cell, of ice particles by the accretion of supercooled cloud droplets. The calculations show that, in a vigorous warm cumulonimbus, it is possible for this process to generate about 1000 C of charge within about 11 min of the activation of ice nuclei at the −10°c level, and that this volume of charge can be subsequently separated by the falling precipitation elements at a rate which can account for the production of several successive lightning flashes over a period of a few minutes. A.

551.594.21

6182. A critical examination of theories of charge generation in thunderstorms. B. J. Mason. *Tellus*, **5**, 446–60 (*Nov.*, 1953).

A concise review is presented of the more important features of the meteorological and electrical behaviour of thunderstorms from which the main conditions to be fulfilled by any satisfactory theory of charge generation, are enumerated. The various theories are then examined, as far as possible from a quantitative point of view, in the light of these requirements. None is found to be entirely satisfactory. It is concluded that the mechanism which most accords with the observed facts is the charge generation and separation which, according to the results of laboratory experiments, will be associated with the growth of graupel pellets in the super-cooled region of the thundercloud. A.

551.594.221

6183. Lightning. T. W. Wormell. *Quart. J. Roy. Meteorol. Soc.*, **79**, 474–89 (*Oct.*, 1953).

Symons Memorial Lecture, a historical and general review.

551.594.25 : 537.221

6184. Experiments concerning electrification of snow. H. Norinder and R. Siksna. *Ark. Geofys.*, **2**, *Paper* 3, 59–89 (1954) In shorter form in *Tellus*, **5**, 260–8 (*Aug.*, 1953).

Electrification of snow and related phenomena were investigated by measuring: (1) the charge of snow when pouring it from a vessel into a funnel, (2) the charging of an insulated target when letting show hit it as well as the charge of the scattered snow, and (3) the charge in air from blowing snow. Specific, basic phenomena were separated. The charge of larger snow particles collected was dependent on the temperature and on the material of the target. The properties of the surfaces seem to be of importance in these phenomena. Enhanced charges of both polarities were measured in air by ion-counters. It seems that these charges are not due to ions, but may be attributed to very small snow particles suspended in air. A complete insight into the whole problem of electrification of snow might be obtained by a systematic consideration of all these specific phenomena. A.

551.594.5 : 537.564

6185. Excitation processes in the aurora and airglow. I. Absolute intensities, relative ultra-violet intensities and electron densities in high latitude aurorae. M. Seaton. *J. atmos. terrest. Phys.*, **4**, *No.* 6, 285 (1954).

The paper discusses certain auroral observati and seeks to obtain information in a form whic best suited to the study of physical processes. attempt is made to express largely descriptive infor tion on the auroral brightness in terms of a quan π (5577), the number of oxygen green line qua emitted, in the line of sight, per cm^2 column second. It is concluded that International Bright Coefficients I, II, III and IV correspond to π (55 being approximately equal to 2×10^9, 1×10^{10}, $1\times$ and 5×10^{12} cm^{-2} sec^{-1}. An extreme upper limi estimated as 5×10^{15} cm^{-2} sec^{-1}. Measured aur intensities in u.v. vibration bands are compared v intensities obtained from theoretical and laborat studies. By considering various v'' progressi (fixed upper state) it is shown that the aur intensities are in error by an amount which increa systematically as the wavelength is decreased. empirical correction curve is obtained. Radio optical evidence on the electron density is discus and it is concluded that electron densities betw 10^7 and 10^8 cm^{-3} occur in bright high-latitude auro

551.594.5 : 537.

6186. Excitation processes in the aurora and airgl II. Excitation of forbidden atomic lines in high latit aurorae. M. J. Seaton. *J. atmos. terrest. Phys.*, *No.* 6, 295–313 (1954).

A summary is given of the various excitation a deactivation processes which may occur, and attempt is made to decide which of these will be major importance. Relative intensities of the [O lines (λ5577, and 6300 + 6364) show that deactivati must occur. If electron deactivation alone occurs, n must be $\geqslant7\times10^7$/cm^3 at the lower border a $\geqslant2\times10^7$/cm^3 at the upper border. It was conclud in Pt I that such values are possible for a brig display. Various deactivation processes involvi collisions with gas molecules are discussed. Althou none of these appear to be particularly promisi there are several processes which may contribu At and above the level of maximum luminosity it considered that the [O I] lines are excited by electr impact. Below this level there is some evidence th an additional excitation mechanism becomes i portant. This is probably $O_2^+ + e \rightarrow O' + O$ Electron deactivation can account for the relati intensities of the [N I] lines (λ3467 and 5199) wi electron densities similar to those required for t [O I] lines. An improbably high degree of nitrog dissociation would be required if electron impact atomic nitrogen was assumed to be responsible f excitation of the [N I] lines. The forbidden li emission rate resulting from $N_2^+ + e \rightarrow N' + N''$ estimated and found to be in good agreement wi observation. Proposed identifications with [N I [O II] and [O III] lines are discussed. The only o for which the identification does not appear to in doubt, [N II] λ5755, is probably excited by di sociative ionization of N_2, $N_2 + X \rightarrow N'^+ N^{+''} e + X$.

551.594.52

. The effect of the horizontal extent of aurorae he apparent luminosity-altitude curves. G. W. FING AND A. L. STEWART. Note in *J. atmos. st. Phys.*, **4**, 339–41 (*Jan.*, 1954).

suspected effect (Meinel, 1952) of the finite zontal spread of aurorae along the geomagnetic dian in concealing the true intensity-altitude ibution is investigated theoretically; and a com- son is made between computed, and observed rang, 1944) data for the variation of luminosity height. Observed intensities agree with those dicted on theoretical grounds except when the , horizontal/vertical extent of the aurora is h >1, which is unlikely. Thus the finite hori- tal spread of the aurora cannot explain the existing repancy between observed, and predicted intensi- , the latter based on the assumption of excitation mono-energetic protons. D. R. BARBER

551.594.6

8. Atmospherics due to fronts in the upper osphere. A. KIMPARA. *J. Geomagn. Geoelect.*, **5**, 3 (*June*, 1953).

For a long time a distinctive zonal distribution of ospherics has been observed on the Pacific Ocean lat. 30° to 40°N all the year round especially in umn and winter. Although they are not so strong those from southern districts, they are often found n in the interior of Asia at night and have a fairly row zonal distribution. Abundant meteorological ormations in the upper atmosphere, furnished by plane observations and radio-soundings in the neighbourhood of Japan, show that they are generated in the convergence region of fronts in the upper atmosphere such as polar fronts. By extending this idea to the middle of the Pacific as well as in the inland of Asia, where no reliable information is obtained, the zonal distribution of atmospherics in lat. 30° to 40°N and long. 80° to 180°E can easily be explained. A.

551.594.7 : 621.317.7.029.6 : 621.396.11

6189. Measurement of variations in atmospheric refractive index with an airborne microwave refractometer. H. E. BUSSEY AND G. BIRNBAUM. *J. Res. Nat. Bur. Stand.*, **51**, 171–8 (*Oct.*, 1953).

A microwave refractometer for aircraft use is described, and some of the sources of error in the measurement of variations of atmospheric refractive index with this instrument are discussed. Observations were made up to 10 000 ft on 2 days near Washington, D.C. Two refractive-index soundings taken 1½ hr apart showed changes that, in the coarser aspects, resembled changes shown by radiosonde data. The fluctuation intensity changed erratically with time and place, but was usually greatest where the vertical gradient was changing. A rough analysis of the data showed that the larger fluctuations occurred over distances of several hundred metres, whereas over distances less than 5 m the fluctuations were negligible (the response of the instrument would have allowed the detection of fluctuations occurring within 0·5 m). Large increases in index were observed on entering cumulus clouds and intense fluctuations were noted within the clouds. A.

BIOLOGY 57/59

578.087.78 : 591.111

90. An apparatus for the measurement of systolic d diastolic pressures. R. M. LANDSMAN. *Rev. sci. trum.*, **25**, 71–2 (*Jan.*, 1954).

Two electronic voltmeters are used to present the stolic and diastolic blood pressure. One of these ltmeters is the peak reading type to show the stolic pressure, the other is a modified peak reading ltmeter which presents the diastolic pressure. This it is applicable to any system which converts essure to a varying d.c. voltage. A.

578.087.9

91. Efficiency and sources of error of the mano- etric measurements of metabolism. A. PIRSON, KROLLPFEIFFER AND G. SCHAEFER. *S.B. Gesell. eförd. Naturwiss. Marburg*, **76**, *No.* 2, 3–27 (1953) *In erman.*

The maximum errors (both the reading errors and ose due to errors in the values of constants) are termined for different manometric methods, thus abling their efficiency to be estimated. Biological urces of error are discussed. The indirect "GD" ethod (two vessels of unequal volume with the same uid content) is described in detail and graphs are ven enabling the gas metabolism quotient and the fect of the reading errors on its value to be directly ad off. F. LACHMAN

578.088.2

6192. Mechanical resonances of amphiuma erythrocytes. E. ACKERMAN. Letter in *J. Acoust. Soc. Amer.*, **26**, 257–8 (*March*, 1954).

Experiments on ciliate protozoans previously reported have been extended to determine the breakdown of amphiuma tridacyla over a range of frequencies from 350 c/s to 35 kc/s. A peak in the breakdown curve was found at 16·5 kc/s. The magnetostriction apparatus used is briefly described. G. F. HODSMAN

591.088.5 : 539.172.4

6193. The biological effectiveness of thermal neutrons on mice. I. J. T. BRENNAN, P. S. HARRIS, R. E. CARTER AND W. H. LANGHAM. *Nucleonics*, **12**, 48–56 (*Feb.*, 1954).

An account of measurements of dose rate in ionization chambers placed in a cavity in the graphite thermal column of the Los Alamos "Water Boiler" is given. The observed dose rate was due partly to thermal neutron flux and partly to γ-radiation. Measurements on the absorption of a collimated beam from the cavity in various materials indicated that the energy of γ-radiation was in the region of 4 MeV. This radiation is identified as 4·9 MeV capture γ-rays from the C. Corresponding to a thermal neutron flux of $1{\cdot}8 \times 10^{10}$ n/sec, the γ dose

rate in the cavity was 49 r/min. Pt II will discuss the irradiation of the mice in the thermal column.

L. R. SHEPHERD

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

61 : 534.321.9

Ultrasound and medicine. A survey of experimental studies. *See Abstr.* 5386

612.843.2

6194. Effect of flash and field luminance upon human reaction time. N. R. BARTLETT AND S. MACLEOD. *J. Opt. Soc. Amer.*, **44**, 306–11 (*April*, 1954).

Reaction time is measured from the onset of a signal flash to the manual release of a microswitch. Responses are made by two trained subjects over wide ranges of stimulus intensity and under varying conditions of signal flash and background field luminance. Two types of experimental conditions prevail: (1) variable flash luminance at each of three field levels, and (2) variable field luminance at three constant flash intensities. Thirty-six reactions are collected for every flash-field combination at each of two fixation positions (foveal and peripheral). The results are described by the following equation: $T = 1/(B \log I/I_0) + K$, where B, I_0 and K depend upon the field luminance. A.

612.843.31

6195. Spectral sensitivity of the fovea. III. Heterochromatic brightness and chromatic adaptation. L. M. HURVICH AND D. JAMESON. *J. Opt. Soc. Amer.*, **44**, 213–22 (*March*, 1954).

For Pt II, see Abstr. 8144 (1953). A series of experiments is reported that extends the study of the foveal threshold luminosity function and its dependence on chromatic adaptation. Heterochromatic brightness matches were made by a large-step, equality-of-brightness method at three luminance levels: 10 mL, 20 mL and 40 mL. Results are compared for chromatically neutral white, and blue, green, yellow and red adapting-surround fields at three levels of adapting luminance: 10 mL, 20 mL and 40 mL. The results for suprathreshold photometric equations confirm the dependence of foveal luminosity on chromatic adaptation demonstrated earlier for threshold sensitivities. The foveal (1°) luminosity function is shown to undergo regular and consistent changes with changes in chromatic adaptation and to be further dependent on the ratio of surround/standard luminance. Implications of these results for the C.I.E. system are touched upon. A.

612.843.611

6196. Dark adaptation to intermediate levels and to complete darkness. R. G. HATTWICK. *J. Opt. Soc. Amer.*, **44**, 223–8 (*March*, 1954).

The course of the change of the visual threshold was measured during adaptation from a high-luminance level to various lower luminance levels and to darkness. Measurements were both foveal and parafoveal. The foveal measurements show photopic function only, while the parafoveal measurements result in duplex curves at the lower luminances. All curves approach their asymptotic values smoothly and gradually. The theoretical and practical implications of the findings are discussed.

612.843.6

6197. An automatic-recording visual adaptometer. S. C. MCLAUGHLIN, JR. *J. Opt. Soc. Amer.*, 312–14 (*April*, 1954).

A visual adaptometer which employs a direct mechanical linkage between brightness-control mechanism and recorder is described. Brightness of the test field, which is controlled by the subject, is uniform, one-half being darker than the other by a small fixed amount. The subject's visual threshold is approximated by requiring him to adjust the brightness of the split field so that he is able to see only the brighter portion of it. The device may be operated by the subject with little or no assistance from the experimenter and yields a nearly continuous plot of absolute visual threshold as a function of time.

612.843.6

6198. Automatic apparatus for stimulus presentation and recording in visual threshold experiments. H. BLACKWELL, B. S. PRITCHARD AND J. G. OHMA *J. Opt. Soc. Amer.*, **44**, 322–6 (*April*, 1954).

An apparatus is described which automatically controls the presentation of light stimuli and records subjects' responses in visual threshold experiments. The apparatus includes: (*a*) A tape reader which controls the magnitude and time of occurrence of light stimuli, in accordance with the location of holes in a programming tape and (*b*) a punch recorder which makes a permanent record of the conditions of each light stimulus and of the responses made by each of four subjects. The accuracy of the stimulus-producing equipment is monitored. Electric counters tally the correct responses made by each subject for each magnitude of light stimulus.

612.845.

6199. Congenital achromatopsia: A report of cases. L. L. SLOAN. *J. Opt. Soc. Amer.*, **44**, 117– (*Feb.*, 1954).

Studies were made of the visual functions of subjects with complete and incomplete achromatopsia, with particular emphasis on measurements of the rates of dark adaptation in a parafoveal region of the retina and at the fovea. When adequate preadaptation to high luminance is achieved, the dark-adaptation curves reveal the presence of some form of photopic receptor in addition to the normal scotopic rods. Both types of receptor are present, not only in the paracentral retina but also at the fovea.

612.8

6200. Motions of the retinal image during fixation. L. A. RIGGS, J. C. ARMINGTON AND F. RATCLIF *J. Opt. Soc. Amer.*, **44**, 315–21 (*April*, 1954).

The ability of an observer to maintain steady fixation on a test object is limited by involuntary eye tremor. Such tremor is characteristic of balanced muscular systems such as those serving to rotate the eye. Rotations of the eye cause proportional displacements of the retinal image of a stationary test object. Data are given for typical excursions of the retinal image during various exposure intervals from 0·01 to 1 sec in duration. The data show that unde

experimental conditions the retinal image is ally stationary for exposures up to 0·01 sec in tion. Exposures of 0·1 sec entail an average acement of 25 sec of arc (a visual angle corre- ding to the diameter of a single foveal cone). sures as long as 1 sec permit an average excursion out 3 min of arc. A.

612.85

. **Note on the definition of the term: hearing by conduction.** G. v. BÉKÉSY. Letter in *J. Acoust. Amer.*, **26,** 106–7 (*Jan.*, 1954).

or a long time hearing by bone conduction has used as a means to distinguish between middle- nfection and incurable nerve deafness, and to-day still used as a means to decide whether or not a ent requires an operation. The paper draws ntion to various ways of defining bone-conduc- . The simplest way is to state that hearing by e conduction takes place when the head is brought contact with the vibrating body—this he calls *ical* bone conduction. In this case the relative vement of the lower jaw may play an important . A second type is referred to as *skull* bone duction and a third type, *labyrinth* bone conduction. concludes that hearing by bone conduction and ring by air conduction produce the same pattern movements of the cochlear partition, and that no er type of stimulation of the hearing nerves occurs to 15 000 c/s. A. B. WOOD

612.85

2. Information of elementary multidimensional litory displays. I. POLLACK AND L. FICKS. *J. oust. Soc. Amer.*, **26,** 155–8 (*March*, 1954).

The information transmission associated with mentary auditory displays consisting of a large mber of independent stimulus aspects, e.g. the quency or the sound level of a tone, was examined. general, multiple stimulus encoding is a satisfactory ocedure for increasing the information transmission ociated with elementary auditory displays. Further, reme subdivision of each stimulus aspect fails to oduce substantial improvement in the information nsmission. A.

612.85

03. A windscreen for the ear. J. R. M. HAYES D A. L. CUDWORTH. Letter in *J. Acoust. Soc. ner.*, **26,** 254–5 (*March*, 1954).

Whenever human beings must hear faint sounds in ndy places, the masking effect of the noise caused air turbulence in the ear canal can be a serious oblem. This masking effect was measured at veral frequencies, wind velocities and wind direc- ons. The reduction of this masking by a wind- reen for the ear was also measured. A.

612.858

04. Note on the paper "Acoustic attenuation between the ears." J. ZWISLOCKI. Letter in *J. Acoust. Soc. Amer.*, **26,** 106 (*Jan.*, 1954).

The note corrects two misleading descriptions which were given in a previous paper [Abstr. 6343 (1953)] relating to experiments by G. v. Békésy. The reference is to Békésy's work on bone conduction [see Abstr. 926 (1949)]. A. B. WOOD

615.849

6205. Some physical aspects of electron beam therapy. J. S. LAUGHLIN, J. OVADIA, J. W. BEATTIE, W. J. HENDERSON, R. A. HARVEY AND L. L. HAAS. *Radiology*, **60,** 165–85 (*Feb.*, 1953).

The practical set up of a 22 MeV betatron, and the extraction of an electron beam whose energy can vary from 5–22 MeV, are fully described. Stray radiation tests near the unit are reported. Distribution of ionization in water for electron beams of different energies and diameters, and specific ionization of electrons in air, have been measured. Aspects of dosimetry include applications of the Bragg–Gray theory and measurement of integral dose. Therapeutic applications are summarized. D. V. MABBS

615.849 : 539.166

6206. Radioisotopes as sources of gamma rays for therapy. P. C. AEBERSOLD. *Amer. J. Roentgenol.*, **70,** 126–35 (*July*, 1953).

A survey concerning production methods, half-life, energy of radiation and γ-ray output of the common pile-produced γ-ray emitters. Tables of properties are given. Some clinical applications of these sources are discussed. D. V. MABBS

615.849 : 539.166

6207. Radioactive gold-198 for gamma radiation therapy. W. G. MYERS, B. H. COLMERY, JR AND W. M. MCLELLON. *Amer. J. Roentgenol.*, **70,** 258–73 (*Aug.*, 1953).

Au^{198} seeds contained in non-radioactive Au tube 0·2 mm wall, are used interstitially as permanent implants. Simple equipment for cutting the seeds is described from photographs. Decay tables for Au^{198} are given. Uniformity in activity of equal lengths cut from a wire, is good. Advantages in physical and clinical effect of Au^{198} over Rn seeds, are given. D. V. MABBS

615.849 : 539.166

6208. The use of cobalt 60 in gamma-ray therapy. E. M. JAPHA. *Amer. J. Roentgenol.*, **69,** 445–65 (*March*, 1953).

Requirements for sheathing interstitial Co^{60} sources are formulated, and the secondary radiation induced in sheaths is calculated. Auto-radiographs of Ra and Co^{60} needles are shown, and problems of dose determination discussed. Dose distribution, calculated for a Co^{60} needle sheathed by 0·3 mm of steel, is shown. Results of comparative experiments, using bleaching of butter as an indicator, show the biological similarity between linear sources of Ra and Co^{60}. D. V. MABBS

TECHNICAL MATERIALS 66/67

666 : 539.169

6209. Some effects of high energy radiation on glass. N. J. KREIDL. *Industr. engng Chem.*, **46**, 170–1 (*Jan.*, 1954).

As atomic energy uses increase, glass remaining transparent under conditions of radiation becomes necessary for optical instrumentation. Most optical glass when exposed to radiation becomes coloured in a manner which may be considered from the viewpoint of well-known effects in crystals. Cerium inhibits coloration due to irradiation; this mechanism is being studied. Glasses are developed to optical specifications incorporating cerium to make them insensitive to stated levels of radiation. In additi glass is used for absorbing radiation and for dosime

666 : 771.

Recent developments in radiation-sensitive glass *See Abstr.* 6211

67 : 534.32

The processing possibilities of ultrasonics. *Abstr.* 5387

672 : 534.32

Uses of ultrasonics in degreasing processes. *Abstr.* 5388

PHOTOGRAPHY 77

771.53

6210. Scattering of light in photographic emulsion layers. G. C. FARNELL. Note in *Proc. Phys. Soc.* [*London*] *B*, **67**, 164–5 (*Feb.*, 1954).

The absorption coeff. of AgBr when dispersed in an emulsion is greater than that of the compact material (5·2 times as great at 3650 Å, 31·5 times at 4500 Å). This is explained by scattering in the emulsion, which increases the light path. S. T. HENDERSON

771.531 : 666

6211. Recent developments in radiation-sensitive glasses. S. D. STOOKEY. *Industr. engng Chem.*, **46**, 174–6 (*Jan.*, 1954).

Photography in glass is growing in new applications, photosensitive compositions and processes. Brief descriptions are given of the nature and present applications of photosensitive metal-coloured and opal glasses, a glass for photo-engraving and chemical machining and a γ-ray dosimeter glass. A new process, described here for the first time, converts a photosensitive glass to a high-strength crystalline material. Another new process reproduces photographic images in ordinary window glass, providing permanence and dimensional stability. A.

771.534.5 : 538.21

6212. Reduction of photographic noise. C. A. FOWLER, JR, AND E. M. FRYER. Letter in *J. Opt. Soc. Amer.*, **44**, 256 (*March*, 1954).

Describes a noise reduction scheme used in a Kerr magneto-optical method of ferromagnetic domain observation. A photographic positive is carefully superposed on the negative so that "noise" is diminished by cancellation and the wanted variations due to Kerr rotations are preserved. A. H. W. BECK

778.34

6213. Action of low temperatures on nuclear emulsions. M. DEBEAUVAIS-WACK. *Nuovo Cimento*, **10**, 1590–4 (*Nov.*, 1953) *In French.*

Nuclear emulsions can be kept satisfactorily for several weeks at very low temperatures provided t are coated on a celluloid support. At −180 Ilford C2 emulsions do not record α-particles, a Ilford G5 emulsions record them as tracks of v low grain density. At −85°c the C2 emulsions rec α-particles as tracks consisting of separated grai and the G5 emulsions are sensitive to electrons energies up to 0·5 MeV. At −85°c the foggi action normally observed when aluminium is pla in contact with these emulsions, is very much reduce A. C. COAT

778.

6214. Correction formula for track counting nuclear emulsions. A. HERPIN AND C. MERCIE *J. Phys. Radium*, **15**, 21–6 (*Jan.*, 1954) *In French.*

Formulae are given relating true track density counts taken in a circular field of view. J. J. WILKI

778.

6215. Influence of fading on the measurement of ma ratios in nuclear emulsion. K. KRISTIANSSON. Lett in *Nature* [*London*] **173**, 78–9 (*Jan.* 9, 1954).

Previous anomalous results [Abstr. 9719 (1951 concerning the mass ratio of π- and μ-mesons a now explained as being due to latent image fading. A. C. COAT

778.34 : 539.1

6216. The preparation of large nuclear emulsio detectors and their application to the study of *K*-meso and hyperons. D. LAL, Y. PAL AND B. PETERS. *Pro Indian Acad. Sci. A*, **38**, 277–87 (*Oct.*, 1953).

A method is described for constructing out individual sheets of nuclear emulsion a detector large volume and stopping power which can be use for observing entire chains of successive nuclear inte action and decay processes initiated by high energ particles. Such a detector which had been expose for several hours in the stratosphere has prove particularly valuable for detecting *K*-mesons an hyperons and for studying their modes of productio and decay. A